SCIENTIFIC AMERICAN SUPPLEMENT. No 1388

Scientific American. established 1845.
Scientific American Supplement. Vol. LIV. No. 1388.

NEW YORK, AUGUST 9, 1902.

Scientific American Supplement. $5 a year.
Scientific American and Supplement. $7 a year.

THE FRENCH SARDINE INDUSTRY.*

By Hugh M. Smith.

Few if any foreign fishery industries are of greater interest or importance to Americans than the sardine industry of France. The wholesome, palatable, and convenient canned sardine is consumed in nearly every community, and the annual importations of French sardines into the United States are worth about $1,000,000, a sum exceeded by the value of but few imported fishery food products.

The sardine of the French coast is a handsome little fish, whose beauty is not entirely lost in canning. In the water the back is of greenish color, but out of the water the upper parts are rich dark-bluish, contrasting strongly with the silvery and white colors of the sides and abdomen. The scales are very easily detached, but their loss does not detract seriously from the appearance of the fish, either when fresh or sardine, when broiled or grilled, has a delicate flavor and is very palatable. It is improved by the slight salting that it usually receives when intended for immediate consumption. The California sardine resembles the French fish in character of flesh and is a more perfect substitute for it than any other American species.

The sardine fishery of France dates back many years, and even in the early part of the eighteenth century it was an important industry, but it has become much more extensive since the introduction of canning.

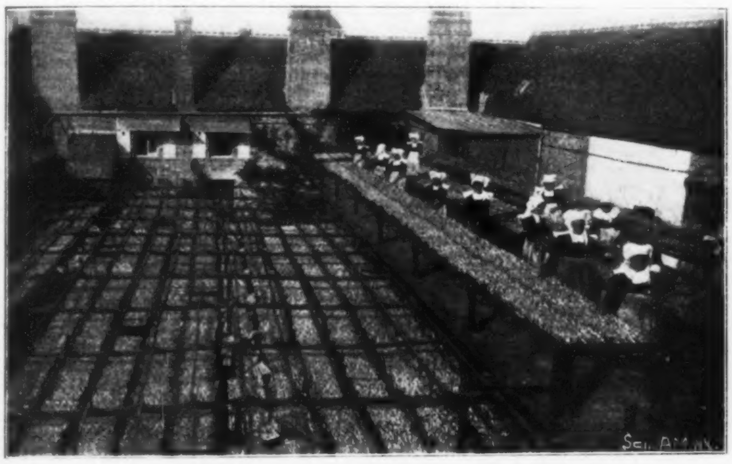
All of the boats engaged in the sardine fishery are registered, and have their numbers in large white figures on both sides of the bow, preceded by a letter or letters indicating the town to which they belong (thus, CC for Concarneau).

The stern is pointed, the prow is sharp and straight, and the sides flare considerably, so that there is great use, and stones are sometimes piled on it in rowing. There are four oars to a boat, each used by one man.

In parts of Brittany nets were formerly used to surround the schools, and then stones were thrown in to frighten the fish into the meshes. In this way large catches were often made and the market was glutted; but the method came into disrepute and is no longer followed. Fishing is now carried on exclusively with gill nets made of very fine cotton twine.

The nets are dyed a bright greenish blue, for the two-fold purpose of preserving the nets and rendering them less conspicuous when in the water. The practice of dyeing the nets blue has been in vogue only a short time and appears to have begun shortly after the introduction of cotton nets.

In the fishery for sardines for canning, bait is almost as important as the boats and nets. In no other net fishery in the world is bait so extensively employed and so essential to the success of the industry. The



YARD OF A LARGE CANNERY, SHOWING SARDINES DRYING ON GRILLS.

YARD OF A CANNERY. WOMEN CUTTERS AWAITING THE ARRIVAL OF SARDINES.

A PART OF THE SARDINE FLEET AT THE DOCK IN CONCARNEAU.

THE DRYING YARD OF A CANNERY. WOMEN WITH SARDINES ON GRILLS.

canned, as the skin is rather thick and has a brilliant uniform silvery color. There are no evident spots on the sides in life, but after the scales are detached a few dark lateral spots may be seen.

Several American fishes resemble the pilchard, among them the sea herring and the California sardine. The former, which is extensively canned on the coast of Maine, may be distinguished from the pilchard by its more elongate form, by the more posterior origin of the dorsal fin, by the smaller and more numerous scales, by the presence of teeth on the vomer, by the much projecting lower jaw, by the smooth operculum, and by the much compressed abdomen. The California sardine is distinguished from the pilchard in having a more elongate form, fewer dorsal rays, a somewhat longer maxillary, and a series of dark spots along the side.

The flesh is dark-colored, rich, and oily. The fresh carrying capacity. There is a broad floor about 2 feet below the rail, and on this platform most of the work is done and most of the fish carried; but when there is a large catch, some of the fish are put below to avoid crushing.

There are two long masts, the foremast raking aft, while the mainmast is nearly vertical. The masts may be lowered if desired. The raising and lowering of the foremast are facilitated by a rope running from its base through a pulley at the head of the mainmast. Each mast carries a large, square, lugger sail, and sometimes a topsail and a jibsail are employed. The sails are either linen or cotton, the latter being used in summer fishing. Linen sails are tanned brown with catechu and cotton sails are colored with ocher.

The oars are 33 feet long, with a very small, narrow blade, and a square butt about 4 inches in diameter. Owing to their great length the butt is made large and heavy in order to balance the oar when in scarcity of bait is always a serious matter in fishing districts, curtailing the catch, reducing the income of the fishermen, and often producing distress among the fisherfolk. It is therefore remarkable that for this indispensable article the French should be absolutely dependent on other countries and that the success of the fishery for sardines should be intimately related to the fisheries for other species in distant lands.

In the early days of the sardine fishery, especially prior to the establishment of canning, small shrimp-like animals, about half an inch in length, were much used as bait. These are one of the natural foods of the sardine and are considered the best bait, but cannot be procured in sufficient quantities to meet the demand and are now rarely used. The gathering of this kind of bait was an occupation of the women, who sought the schools in the bays and coves, catching them in large canvas bag-nets. They frequently made their best catches in water up to their necks, when the weather was bad and the water along the shores

* Extracted from U. S. Fish Commission Bulletin for 1901.

was thick. The crustacea were heavily salted in barrels and retained until required. The taking of these little creatures appears to have been prohibited many years ago, because of the supposed destruction of fish eggs at the time of catching the shrimps. Although the interdiction is now removed, little effort is made to secure this form of bait.

The bait now in general use is the salted eggs of the cod (*Gadus callarias*), though the eggs of hake, haddock, pollock, cusk, herring, mackerel, and many other fishes are also employed.

For at least two centuries cod roe has been imported from Norway, which country has always furnished the greater part of the sardine bait. Other countries which have contributed supplies are Holland, Newfoundland, and the United States. From time to time the French government has encouraged its own cod fishermen (at St. Pierre and Miquelon; on the Grand Banks; in the waters of Iceland, and in the North Sea) to preserve the roes of cod and other fish, and in 1816 offered a bounty of $4 a barrel for roe made from fish caught by them; but this and other inducements have had little effect on the supply from native sources.

Sardines are caught in greater or less numbers throughout the year. On the west coast, however, the fishing season opens in February and continues to November, rarely extending into December. In Brittany the fishing begins rather later and continues longer than at points farther south on the Bay of Biscay. Fishing in the canning district is continued as late as practicable, usually as long as the fish remain in abundance, as their condition at that time is good. In the Mediterranean sardines are caught during every month of the year.

The sardine fishery is emphatically a shore fishery, and most of it is done within a very short distance of the home ports. This permits the use of smaller and less expensive boats than would otherwise be required, and insures the landing of the fish a short time after capture.

When a boat arrives on the fishing-grounds the rear mast is taken down and the boat is headed toward the wind. If fish are present a net is shot and slowly towed by means of a short line attached to the cork line and fastened in the stern of the boat.

The casting of the bait, on the proper use of which a great deal of the success of fishing depends, is always done by the master or "patron," who stands in the stern of the boat on a little platform and uses the flour and roe as required. When the fish have come toward the surface and are on one side or the other of the net his object is to cast the bait in such a way that they will rush against the net and become gilled.

Considerable skill and experience are of course necessary in managing the net and in having it hang properly in the water and not become folded or wavy owing to currents or tide. Unless the net is straight or gently curved, the fish will see and avoid it. When a net contains fish and is ready for hauling, it is taken in the boat and the fish are removed from the meshes by gently shaking the net or by hand.

The sardines are often found in a more or less compact body, and the boats will be concentrated in a comparatively small area, at times so close together that the operation of the nets would seem almost impossible and the chance of catching fish very improbable. The entire fleet of a given port—consisting of several hundred boats—may be at work on one school and fishing literally en masse instead of individually.

No ice or other preservative is used on the fish, which are landed a short time after gilling. The fish reach port in good condition, and are often at the canneries within one or two hours after capture.

Soon after reaching port the nets are spread for drying, being hauled to the top of the masts and suspended between them for this purpose. When all the fleet has arrived and the nets are spread, the view of the maze of blue nets, sails, and masts is most interesting and unique.

When the fish are taken to the factory they are spread on large tables and sprinkled with a little salt. The women who remove the heads and viscera either stand or sit, and perform their work with great rapidity. They hold the fish in the left hand and with the right hand press the knife into the back and side of the head of the fish, using the right thumb for a counter pressure. The head is pulled or torn off, rather than cut, and the esophagus, stomach and most of the intestines go with it. The body drops into one basket, the refuse parts into another. The refuse is disposed of to farmers for fertilizing their fields.

Immediately after evisceration the fish are sorted by size into large tubs (half oil barrels holding 250 liters) containing a brine strong enough to float a potato. Here they are left for half to an hour, depending on their size, quality and the condition of the weather. They are then placed in small wicker baskets and taken to the yard, where they are washed in either fresh or salt water (salt preferred) while in the baskets, each basket being put through two waters. This washing, which takes but a few seconds, removes from the fish any undissolved salt, loose scales and dirt.

Drying, which is the next step, is preferably done in the open air, and a large part of the product is so treated. For open-air drying the fish are arranged by hand, one by one, in wire baskets or trays holding about 150 fish of medium size, placed on wooden frames or flakes. The baskets are 16 or 18 inches long, 9 inches wide and $3\frac{1}{2}$ inches deep; are made of coarse wire with a polygonal mesh two-thirds or three-fourths inch in diameter, and have a long bridle-like wire handle on each side by which they are suspended on the flakes, each bridle having at its middle a loop or ring which interlocks with its fellow. The distinctive feature of this wire tray is its division into about seven crosswise compartments, V-shaped in section, the spaces being pointed at the bottom and open above. The divisions are of coarse wire, and one side of the V forms a wider angle with the basket bottom than the other. Against the more oblique sides the sardines are placed in regular rows, with their tails upward, so as to promote the escape of water from the abdominal cavity.

The sardines remain out for a variable time, depending on their size, the state of the atmosphere, etc. The usual time in favorable weather is one hour.

In damp, foggy or rainy weather (especially in autumn), the sardines must be dried indoors by artificial heat, and drying ensues much sooner than in the open air.

From the drying flakes the fish are taken in the same wire baskets to the cooking room and immersed in boiling oil, in open vats of various sizes and construction. As the fish are quite dry, much of the oil is taken up in cooking and has to be replaced from time to time by fresh oil. The immersion in oil usually lasts about two minutes, but depends on the size of the fish and is best gaged by experience. When the caudal fin will break easily, the fish are said to be cooked enough. The baskets are then removed to a table or platform with an inclined metal top, where the surplus oil is allowed to drain from the fish. After a few minutes the baskets are taken to the packing room, where they are hung on wooden frames oves metal-top tables for further draining and cooling.

The sardine manufacturers employ two kinds of oil in their canning operations—olive oil and arachide or peanut oil; and small quantities of sesame oil have at times been used. While it is reported that the manufacturers knowingly handle only the oils named, it is understood that cottonseed oil, being tasteless and cheap, is used by the French oil dealers for adulterating both olive and peanut oil. Information on this subject is naturally difficult to obtain; but the testimony of several oil manufacturers and dealers clearly indicates the existence of the practice. It is interesting to note, in this connection, that during the fiscal year 1899 the United States exported to France nearly 17,000,000 gallons of cottonseed oil, having a value of $4,000,000.

French olive oil is used with the best quality of canned sardines. Fish packed in it will remain in good condition ten years or longer, and are reported to be better the second year after packing than earlier.

Peanut oil is largely used to meet the American demand for a low-priced sardine. Most of the cheaper French sardines exported to America are packed in peanut oil, which is practically tasteless.

There are various other ingredients with which or in which the sardines are packed to give them flavor or piquancy. Some of the very best goods are prepared with melted butter of good quality instead of oil; these are mostly for special French trade. Tomato sauce, pickles and truffles are also used. With all of these the sardines are packed precisely as when oil is employed and in cans of the same sizes. Only relatively small quantities of such goods are prepared.

When the fish reach the packing room, the women who had been cutting will probably have finished that task and are seated at a table ready to take up the packing of the sardines in tin boxes; they carefully place the fish in the cans, and then pass them along to another set of women who fill the boxes with oil from a faucet or with other materials used with the sardines—tomato sauce, mustard, truffles, etc.

In some countries (United States) the trade demands that the blue back of the sardines be uppermost when the box is opened; while for other countries (France, Belgium) the white belly should be uppermost.

With most of the oil sardines a small quantity of spices is used in order to impart a flavor. The usual ingredients for each can are one or two cloves, quarter or half of a laurel leaf, and a small piece of thyme; these are put in the can before the fish, so that they will be on top when the can is opened. The fresh leaves of tarragon (*estragon*) are sometimes used.

LIQUID FUEL FOR STEAM PURPOSES.

THE possibility of burning a liquid fuel with very great advantage in most circumstances as compared with a solid fuel has been so long recognized that it is astonishing the practice has not been more generally adopted. The success which has been gained in the last few years, however, will undoubtedly lead to a greatly extended use in the near future.

Naturally the choice of a fuel for steam raising is not altogether dependent upon the evaporative efficiency and other advantages which a particular one may possess, but will, of course, be largely influenced by relative market prices, and this, no doubt, has had considerable influence against the adoption of liquid fuel on a large scale in this country. The fuel natural to the locality will always have great advantages over an imported fuel, and England, having such valuable coal supplies to hand, while on the other hand having no great natural sources of liquid fuel, gives preference to that material which renders it most independent of outside supplies. Although gas tar and oil gas refuse may be frequently employed in a very economical manner, yet there is little doubt that with a greatly extended use of liquid fuel the prices of suitable bye-products would be so enhanced that imported liquid fuel would remain practically in possession of the field.

For this reason engineers who have perfected the methods of burning liquid fuel have always considered the possibility of its use becoming limited in certain circumstances, and all modern appliances are so constructed that with slight trouble coal alone may be used in them to the best advantage. One of the great claims to be considered in favor of liquid fuel is the ease with which the burners can be extinguished and a coal fire substituted, thus enabling consumers to take every advantage of fluctuations in the prices of both fuels. For marine purposes this is most desirable, since at many ports liquid fuel would be far more economical to ship for boiler use than a suitable steam coal, while a vessel trading from a port such as Cardiff or Newport would naturally replenish her bunkers with the steam coal at hand.

Any liquid hydrocarbon of sufficiently high flash point may be used as a liquid fuel; thus residues from many manufacturing processes may be utilized in an economical manner. Astatki, the residuum from petroleum distillation, has been extensively used in Eastern Europe, but tar oils and the oils from oil gas plants are frequently employed. These oils are especially suitable for locomotive work, since most large railways make oil gas in considerable quantities for lighting purposes, and, moreover, have exceptional facilities for transporting gas tar from small towns on their lines where it can be obtained at a reasonable cost. On the Great Eastern Railway this form of liquid fuel is largely employed. Crude petroleum, which has been treated to remove the more volatile constituents and so bring its flash point above the imposed limit for use as fuel, is now being imported into this country. The various methods of burning liquid fuel has been classified by Aydon as follows:

(1) Injection with compressed air (W. Bridges Adams, 1863; Tarbutt, 1885.)

(2) Percolation through a porous bed (C. J. Richardson, 1864; Weir and Gray; St. Caire Deville), in which the liquid fuel percolates upward through a porous bed, accompanied by heated air (and sometimes steam also).

(3) Vaporization (Foote; Simm and Barff, 1865-67), the oil being vaporized from a small retort heated in the furnace, or in some cases (Dorsett, 1868-69; Eames, 1875) by a special external heater for the retort.

(4) Steam spray injection (Aydon, Wise and Field, 1865-67), in which the oil is sprayed into the combustion chamber by a jet of steam, while in the same time the burner is so constructed that air, heated if possible, is drawn in to supply the oxygen necessary for combustion.

Such a classification does not include burning in open troughs, a method first introduced by Wittenström about the year 1884, and which for many purposes in stationary boilers, furnaces, etc., has met with considerable success; or the more recent method of Korting, by direct injection of heated oil at considerable pressure.

Excepting in a few special cases, the steam spray injection method have been universally adopted. Various extravagant claims have been made for the chemical action of the steam, but it is not easy to see from a theoretical standpoint that it has any advantage over injection by compressed air. From a practical point of view, however, the steam spray is the more simple, since it dispenses with the auxiliary apparatus necessary for the supply of the air blast. On a locomotive, where economy of space is of importance and suitable water for the boilers is readily obtainable, steam spray injection is universal. For marine boilers the choice formerly lay between steam and air injection, each having certain advantages. Using steam injection, the auxiliary apparatus necessary for the air-blast is done away with, thus giving economy to space, while it has the disadvantage of requiring more condensed water from the evaporators to replace the steam used. On the other hand, the extra steam necessary for the air-blowers can be condensed and returned in the usual way to the feed water-pipe, but of necessity extra machinery has to be employed. With the introduction of the Korting system referred to above, and the success which has attended its use, notably on the Hamburg-American Line steamers, the marine engineer now has the choice of another method, and everything seems favorable to the extensive adoption of this new system in the future.

From the numerous estimations of the calorific value of different liquid fuels, we may approximately state that in centigrade units it has a value of 10,500, while for good steam coal a value of 8000 to 8500 may be taken. It will thus be seen that the liquid fuel has a decided advantage. The usual calculations of the theoretical heating value of a fuel fail to take one important factor into consideration, namely, the physical condition of the fuel. Thus the determined calorific value of carbon is always that of solid carbon, the value for hydrogen being obtained experimentally for hydrogen gas; but although in coal the carbon is in the solid form, it is certain that in liquid fuels it has undergone the first change in the passage of a solid to a gaseous condition, and consequently carbon in a liquid fuel will have a higher calorific value by just as much heat as would be required theoretically to raise solid carbon to the liquid condition. Aydon has estimated that this is equivalent to an expenditure of some 3500 calories.

It is, of course, impossible even with the most perfect appliances to obtain anything like the full heating effect of a fuel in any boiler, and the only real test of the value of competing fuels is their performance under similar conditions in practice. One is struck at the outset with the extremely contradictory figures which have been published to show the evaporative duty of liquid fuel, figures ranging from 46 lbs. of water per lb. of fuel burnt to 14 or 16 lbs. per lb. It may be taken, however, that in modern practice an efficiency of 15 lbs. by steam injection is a very fair result. Many comparisons have been made with coal in the same boilers and under the same conditions with results varying from 7 to $8\frac{1}{2}$ lbs. of water evaporated per lb. of coal consumed. A valuable series of tests made by the Engineers' Club of Philadelphia in 1892 gave the following results:

1 lb. anthracite evaporated...	9.7	lbs. of water
1 lb. bituminous coal........	10.14	" "
1 lb. oil 36° B................	16.48	" "
1 cu. ft. of gas 20 C. P.......	1.28	" "

We are indebted to the carefully recorded results obtained by Mr. Urquhart on the Grazi and Tzaritzin Railway for probably the best published figures of the relative merits of solid and liquid fuels. In winter he found that liquid fuel was 41 per cent in weight and 55 per cent in cost better than anthracite coal; or, compared with bituminous coal, 49 per cent by weight and 61 per cent in cost better. This was under the worst climatic conditions, and, as might be expected, in summer better results still were obtained. It must be borne in mind that these figures were deduced from the work of a large number of engines.

The Canadian Pacific Railway find that liquid fuel in use on their steamers effects a saving of 56 per cent on the cost of coal firing.

In this country the pioneer of liquid fuel on our railways is Mr. James Holden and his company; the Great Eastern Railway has now more than sixty engines

burning it, either alone or in conjunction with coal. In a note presented at the International Railway Congress in 1900, Mr. Holden gives the following particulars of express trains running between Liverpool Street and Cromer. The distance of 138 miles is covered in 175 minutes with a four minutes' stop, on a consumption of 14.4 lbs. of tar residues per train mile, and an equivalent of 5 lbs. per mile of coal, which is used in raising the steam necessary for starting the oil injectors. In the same paper it is stated that on railways working with wood fuel a saving of 50 per cent has been effected by burning liquid fuel. Through the kindness of Mr. Holden, the writer recently made a long run on an engine burning crude coal tar over a coal fire with the Holden steam injectors, and was impressed with the ease of maintaining a regular steam pressure and the freedom from smoke.

The South Eastern and other railways are now fitting engines for this class of fuel, and an oil-fired engine is used for shunting on the Central London Railway. Boilers are also being fitted for liquid fuel at Woolwich Arsenal, and its use is extending among private firms.

In the English shipping trade the pioneers have been Messrs. Samuel & Co., the managers of the Shell Transport Company, and a reference to the excellent performance of their vessel, the steamship "Clam," will be found in a recent number of Nature. An interesting account of the record voyage under liquid fuel appears in the Shipping Gazette of February 13, the vessel being the steamship "Murex," also belonging to the Shell Transport Company. This ship arrived at Thames Haven from Borneo via Singapore and the Cape on March 10, having steamed 11,830 miles on a consumption of 800 tons of prepared fuel. The average daily consumption was from 17 to 18½ tons, while the same vessel when under coal used from 24 to 25 tons.

The economy of cost in liquid fuel does not lie entirely in its superior evaporative value, for several other factors are all in its favor, and probably the greatest of these in the marine service is the reduction in the stokehold staff. Potter states that with fourteen tubular boilers (16 feet x 5 feet) twenty-five men were required for stoking with coal, but on the introduction of liquid fuel six men sufficed. On the steamship "Murex," referred to above, while more than twenty stokers were required when under coal fires, only three were carried to attend the oil burners. When the cost of wages, food, etc., for the large number of stokers carried on an average liner are taken into consideration, the possibilities for economy by the adoption of liquid fuel, when it can be obtained at a reasonable price, are very great. In the Royal Navy, where the stokers carried on a battleship run into big numbers, not only does liquid fuel tend to economy, but an even more important factor—the number of lives risked in an engagement—would be largely reduced. It is terrible to contemplate the fate of the engine-room staff in the event of one of our big ironclads being sunk by a torpedo or the ram of an adversary's ship.

For storage, liquid fuel has a slight advantage over coal. In general terms it may be said that one ton of liquid fuel will require 36 cubic feet of storage and steam coal from 43 to 45 cubic feet; but it must be remembered that coal bunkers have of necessity to be specially arranged for the easy delivery of the fuel at the stokehold level, whereas liquid fuel may be carried in places where the storage of a solid fuel is quite out of the question. By the adoption of some system of removing water from the oil, such as that of Flannery and Boyd, where two settling tanks are alternately employed, liquid fuel may be stored in water-ballast tanks and the fore and aft peaks of the vessel. Remembering that one ton of oil fuel has such a much larger evaporative efficiency than the same weight of coal, and, further, has advantages in storage, a very much larger cargo space can be reserved in a vessel, or in the case of the belligerent marine, with no greater total weight of fuel on board, a very greatly extended radius of action can be obtained.

A point in connection with coal as a fuel in steamships which is often overlooked is the large amount of inert material which must necessarily be carried in the bunkers; for example, a ship takes into her bunkers 2000 tons of steam coal (H. M. S. "Queen," which was recently launched, has a coal capacity of 2040 tons), and taking a fair estimate of the ash of this coal at 5 per cent, it means finding space for at least one hundred tons of non-usable mineral matter, even assuming that the ash and clinker do not exceed the ash of the coal. In the case of liquid fuel, the whole amount stored is actually available as fuel, and there is no trouble with ash or clinker in the furnaces, or solid waste of any description to be got rid of.

On any vessel, and especially on a ship carrying passengers, the operation of coaling is a particularly disagreeable one. With liquid fuel there is really no inconvenience, for the oil can be pumped into the tanks in much less time than coal shipment takes, and, further, all the dirt associated with "bunkering" is avoided. At the present time it is well known that the Admiralty is carrying out experiments in coaling war vessels at sea, the collier being made fast astern and the coal hauled along a suitable transport arrangement. It would undoubtedly be a much simpler operation to transfer liquid fuel through a flexible hose of slightly greater length than the cables made fast between the two vessels, providing that an oil of reasonable viscosity was employed.

Even in a country possessing such splendid supplies of steam coal as England, liquid fuel is now making rapid headway, and this is not surprising when one considers the high prices reached for coal of all descriptions during the last two or three years. To be able to fall back on liquid fuel, when it can be obtained at a reasonable price, places the consumer in an independent position as regards the colliery proprietor, and the necessary fittings to enable this to be done are by no means costly. Coal at a fair price will probably always have the advantage over imported liquid fuel, but in countries entirely dependent upon imported fuel, the liquid form must in the future be the main supply, for bulk for bulk it is twice as efficient as any solid fuel, and, moreover, its transport in suitable vessels is attended with far less risk than with coal cargoes shipped from a great distance.—J. S. S. Brame, in Nature.

NEW METHODS OF TESTING IRON AND STEEL.

SOME of the new methods of testing iron and steel which have been proposed and even adopted within the last two years may ultimately render the engineer independent of all appliances for testing except the microscope and the galvanometer. Metallography or microscopic metallurgy has certainly come to stay, and although our knowledge of this recondite subject is as yet far from satisfactory, much reliance is placed even at the present time in many iron and steel works on information afforded by the microscope.

The modern engineer can test his raw material in many ways, but he cannot often test the material when it has been worked up into the finished article. A gas or steam engine, for instance, can be run on a brake test, but there is never absolute security that the connecting-rod or the flywheel is not near its limit of strength owing to an overstrain in some part of the metal. A railway girder-bridge may be tested by loading it with pig iron or a heavy moving train, but weak points can only be definitely discovered by testing to destruction, which would make the bridge useless. But if our metallographists are right, the problem is capable of solution, and two examples may be given to show what has been accomplished and what remains to be done.

The electrician knows that under treatment iron and steel are very liable to changes in their magnetic properties, and he is therefore desirous of testing them in bulk when ready for use. Suppose, for example, that a cast-steel dynamo-frame has to be tested. The usual practice was to cast on projections which could be cut off and trimmed up to form a test piece. This was a very expensive process. Mr. C. V. Drysdale has devised a much handier method. He bores an annular hole anywhere in the casting, or in a boss specially left for the purpose, leaving a central pin 1-10 inch in diameter. A plug carrying two coils is placed round the pin, one coil being in circuit with a battery, ammeter, and reversing-switch, while the other is connected to a ballistic galvanometer. In a very few minutes hysteresis and other curves dear to the electrician can be produced, while a simple drill is making ready for another test at a minimum of expense and inconvenience.

If Mr. C. A. P. Turner's prognostications, set forth recently before the American Society of Civil Engineers, can be believed, the testing of a bridge would be an equally simple matter. Mr. Barus once observed that many phenomena had been forced "by methods of exquisite physical torture" into the service of calorimetry. Now minute temperature changes in turn are pressed into service of tensile testing. If metal is heated it expands; conversely, if stretched by the application of external force to the specimen it becomes cooler. The action is similar to that which occurs when ammonia-gas is used for refrigerating, and Lord Kelvin has given a formula connecting the temperature and the load in the case of metals. Within the elastic limit, before the metal begins to stretch beyond its power of recovery, the fall of temperature under tension or the rise under compression is exceedingly minute, but it can be measured by the aid of a delicate galvanometer and a thermo-couple. Furthermore, within certain limits the temperature change is strictly proportional to the load, so that the measurement of one will indicate the value of the other. Now comes a very curious point. This thermal ratio begins to break away from proportionality some time before the metal passes the elastic limit up to which steel must not be strained without danger, and this point corresponds very closely with that shown by Wohler to be dangerous for unlimited repetition of alternating stress, such as the bending up and down in a badly supported shaft. When the load is increased up to the elastic limit the cooling effect of tension is masked by a rise of temperature, which is evidently caused by the friction due to the commencement of molecular flow. Beyond that limit the metal stretches and rapidly becomes warm, as may have been experienced by anyone who has picked up a quickly broken test-bar.

A facetious engineer once said of a certain ruined bridge that it had only stood so long as it had by force of habit. If Mr. Turner's method could be brought to perfection, a thermo-couple presented to the warming or cooling effect of the strain of a passing train on a strut or a tie respectively would soon disclose whether the member in question were overstrained and liable to give way. Mr. Turner goes even further, and proposes a method by which the state of strain could be tested without the danger of additional load. A piece of strained metal pressed to a piece of unstrained metal of the same quality will generate a feeble current when the junction is heated, but, feeble as it is, the current can be measured and enable the condition of the bridge to be determined.

Such possibilities read like a fairy tale, but they take their place in a quiet way beside wireless telegraphy and X-rays. The latter do not enable us to see through a brick wall; but Mr. Queneau, rivalling the sages of Laputa, though on much firmer ground, hopes to be able to tell the thickness of a basalt dyke by measuring the size of the crystals at and near its surface. And this is not quite such a visionary scheme as that of taking Röntgen-ray photographs of the earth's crust to explore for the precious metals.—The Ironmonger.

VAGARIES OF THE TIDE.

THERE are as many vagaries in the waters as in the winds. Why, for instance, should three great ocean currents send their warm waters across the wide Pacific, Atlantic and across the Cape of Good Hope? Many theories have been advanced to solve the problem of their origin, but all have proved fallacious. Other and equally mysterious currents exist in well nigh all parts of the world. The tides are so erratic in different parts of the world that one hesitates to accept the theory that the moon controls them in all cases, says the London Shipping World. It is on record that the sea has run for weeks out of the Java Sea through the Straits of Sunda and thence back again for a like period without any perceptible rise or fall during those times. Then there is the equatorial current that flows into the Caribbean Sea, the everflowing current to the eastward around Cape Horn, the cold stream flowing from the icy regions of the north past Newfoundland and Nova Scotia and along the American coast to the extreme end of Florida, the continual current running with a velocity of from four to five knots an hour through the Straits of Gibraltar into the Mediterranean Sea, the swift current running across the rocks and shoals off the end of Billiton Island, which apparently starts from nowhere and ends somewhere in the vicinity of the same place, and the current which, starting half way up the China sea, runs from two to three knots an hour to the northeast and finally ends abruptly off the north end of Luzon. Then we have those tidal vagaries known the world over as bores. Residents on Severnside are familiar with them, and those that run up the Hooghly and Irrawaddy rivers, from side to side, in a zigzag shape, till they reach their limit, often tearing the ships from anchorage, originate nobody knows where or why. The rush of waters in the Bay of Fundy is nothing but a huge bore sweeping all before it up to the head of the bay till the western waters have risen to the height of 50 or 60 feet. Off Southampton we have the double tides, while at Singapore it has been observed for days at a time that there has been but one rise and fall in the twenty-four hours. The tides may be, and very often appear as though they were, "moon struck," but they certainly are not controlled with hard and fast rules by that or any other body.

A MODERN TYCHO BRAHE.

MR. E. WALTER MAUNDER contributes, in Knowledge, a striking account of the original work accomplished by the humblest means by a recluse in an obscure Indian village, whom he compares to Tycho Brahe. After relating the story of the foundation of the observatories of Jeypore, Delhi, and Benares, in the course of which Mr. Maunder mildly chides Europeans for an astronomical ignorance in which they compare but poorly with the average Hindu, he says: "The interest of these observatories lies for us in the fact that they recall a time far in the past when astronomers sought for exactness by the erection of huge structures of stone. Of these the Great Pyramid is by far the greatest and most perfect example. Britain has its own monument—Stonehenge—which has been claimed as, if not indeed an astronomical observatory, at least an astronomical temple, and many attempts have been made to determine the date at which it was erected. The difficulty, not to say the impossibility, of solving this problem in the present state of the monument may be inferred from the fact that the dates which different careful observers have deduced for its erection extend over a period of more than 2000 years. The real work of astronomy was never done in edifices like these. Nor, indeed, does it require much knowledge of human nature, essentially the same 5000 years ago as to-day, to see that the true secret of the Pyramid, the amply sufficient cause for its building, was the vanity of the ruling Pharaoh. Alike at Delhi, at Ghizeh, and on Salisbury Plain, as by the Euhprates, to 'make a name' was the exciting motive. Astronomers may have been employed to superintend the work, astronomy, or the cult of the celestial bodies, may have been the excuse, but the real object was advertisement.

"But the work which the pretentious buildings of the Rajah of Amber failed to accomplish has been done quite recently by a recluse in an obscure village in the hills of Orissa. Chandrasekhara Simha Samanta is a near relative of the Raja of Khandapara, one of the tributary chiefs of Orissa. At the early age of ten, having been taught a little astrology by one of his uncles, he became most anxious to measure on his own account the positions of the stars in the nightly movements, and by the time that he was fifteen years of age and had learned to calculate the ephemerides of the planets and of the risings and settings of stars, he was deeply disappointed to find how great was the discordance between his calculations and what he actually observed. In this difficulty Chandrasekhara had to work out his problem unaided. He had to make his instruments for himself, to some extent he had to devise them. The one of which he was fondest is a tangent staff consisting of a thin rod of wood twenty-four digits long, at the end of which is fixed another rod at right angles in the form of T. The cross piece is notched and also pierced with holes equal to the tangents of the angles formed at the free extremity of the other rod. In his discussion of the moon's motion, he made the discovery—independent and original on his part—of the lunar evection, variation and annual equation, which found no place in the earlier Siddhantas. To have obtained such important results and so high a degree of accuracy, by naked-eye observations and with entirely home-made instruments, and in the utter absence of modern book learning, is a striking illustration of what resolution can effect. Chandrasekhara has been compared to Tycho Brahe, and the comparison is in many ways a just one, though the recluse of Orissa lacked many of the advantages possessed by the noble Dane. As to the accuracy of Tycho's work, it will be remembered that Kepler was led to the first of his three great laws by finding that his theory of the circular motion of the planets was irreconcilable with an observation of Mars by Tycho by eight minutes of arc—but one-fourth of the moon's diameter—Kepler concluding that it was impossible that so good an observer could be in error to this extent, abandoned his hypothesis and tried that of motion in an ellipse. In the recluse of the Orissa village we seem to see one of the earlier fathers of the science long centuries ere the telescope was dreamed of, as he grappled with the problems which the planetary movements offered to him for solution. More than that, he affords an example of the achievements within the reach of the naked-eye astronomers, and a telling illustration of the precision which patience and practice can give to hand and eye. And these are always needed. For be the telescope ever so good and powerful, still that which is by far the most important is the man at the eye-end."

THE HISTORY OF THE ANCHOR.

The ships' anchors in general use, up to the beginning of the last century, consisted of a long, round, iron shank, having two comparatively short, straight arms, or flukes, inclined to the shank at an angle of about 40 degrees, and meeting it in a somewhat sharp point at the crown. In large anchors, the bulky wooden stock was built up of several pieces, hooped together, the whole tapering outward to the ends, especially on the after or cable side.

About the beginning of the last century, a clerk in Plymouth naval yard, Pering by name, suggested certain improvements, the most important of which was making the arms curved instead of straight. At first sight, this simple change may seem of little value, but consideration will show that this is not the case. The holding power of an anchor depends on two principal conditions, namely, the extent of useful holding surface, and the amount of vertical penetration. The latter quality is necessary on account of the nature of ordinary sea bottoms, the surface layers of which are generally less tenacious and resisting than is the ground a short distance below. Now the measure of penetration, and also, to a limited degree, that of useful holding surface, is the vertical distance from the lower portion of shank to the pea, or extreme end of the arm, when fully buried. The distance evidently depends on the length and on the inclination of the arm. Some inclination the arm must have, in order to bring about penetration; yet the more at right angles to the shank, the greater the penetration. These two opposing conditions are reconciled by curving the arm to the arc of a circle having its center in such a position that the radius of the curve is about a third of the length of shank. Two minor advantages also accrue. During the process of tripping or breaking out the anchor, the buried arm continues its curved path in the ground until the shank is nearly vertical and the pea ready to emerge with the least possible resistance. The old-fashioned straight arm, on the other hand, retained a more or less horizontal direction in the ground, until the leverage derived from the effective length of shank became very much reduced. Again, with straight arms there exists considerable resistance to penetration, because the entire anchor must move longitudinally before the arm can bury itself; but with curved arms the weight alone of shank and upper arm suffice to bury the anchor in soft bottoms without longitudinal displacement. This last consideration, which has some bearing in the case of modern stockless anchors with two blades, was again referred to when dealing with the Martin's type of anchor.

In the year 1831 chain cables began to supersede the hempen ones, with the result that the long-shanked anchors hitherto in vogue were no longer necessary, and anchors with shorter shanks and with heavier and stronger crowns gradually came into use. In consequence of these changes, a commission was appointed in the year 1838 to inquire into the holding power of anchors, and a principal result of their labors was the adoption of the so-called admiralty pattern anchor, which continued to be used in the navy up to 1860. The invention of the steam hammer in 1842 made the welding of heavy masses of iron a comparatively easy and reliable process, so that from this time onward the strength of anchors fully kept pace with that of the chain cables which had come into general use. A great number of patents for anchors were taken out prior to the great exhibition of 1851, and public attention having been called to the models there shown, in the following year a committee was appointed by the admiralty to report on the qualifications of anchors of the various kinds. Practical trials were then instituted, and, as a result, Trotman's anchor took the highest place out of eight competitors, Rodger's anchor being second on the list. Some of the tests to which the anchors were submitted were of doubtful value, such for instance, as "facility for sweeping." Nowadays, at all events for deep ships in shallow harbors, it is considered an advantage for an anchor to offer as little obstruction as possible above the ground. In this particular test, as also in some others of small importance, Trotman's anchor was handicapped as against those of ordinary form, yet it came out first owing to its undoubted superiority in holding power.

HOW WOOL IS COMBED.

When a blend of wool is made, it is not long before we have a sample of top. First the wool is scoured, and it is done well, on purpose to get the best color possible, this being an important and valuable factor in tops. Readers can put it down as a fundamental principle that better the color and better the price, so growers should not tamper with the growing fleece by dipping it in any sheep dip at all injurious to the color of the wool. After being scoured there are the burrs to extract, then come the preparing, carding, gilling and combing. To describe these processes is beyond the scope of this letter, but to any sheep and wool man they are indeed highly interesting and educative in their influence. It is, however, the combing machine which gives us "tops" and "noils," and it is the price of these commodities which always determines the actual price of the raw article. By "tops" we mean the long fibers of wool got together by the combing machine, every one of which is placed parallel to each other until a long sliver is formed resembling very much a string of tape.

Nothing is more attractive about a wool-combing plant than to see a pile of balls of tops all ready for being sheeted. The white, clean finished appearance of the wool in itself is a picture, causing many a one to wonder concerning the ingenuity of man at inventing such a process as that of wool combing. The Boston Journal of Commerce and Textile Industries says that previous to machine wool combing it was all done by hand, but how in the world it was possible to get a long, continuous sliver, is more than we can tell. Of course, in those days, say sixty years ago, the great thing in wool was length of staple, and longer the staple and more valuable the wool. In those days the hand combing of the Merino was impossible on account of the shortness of the staple, but to-day thousands of bales of short six months' growth of Cape wools are combed every year. In the old times Merino wools were only used for carding purposes in the manufacture of woolen cloths, but it speaks volumes for the advance which has been made in machine construction when wool can be combed of six months' growth. Sixty years ago only such wools as the Lincoln and Leicester could be combed, no matter how short or long, though in speaking of short combing wools the staple should not be less than an inch and a half in length, that is, if you want to make a decent top.

A NEW ACETYLENE GENERATOR.

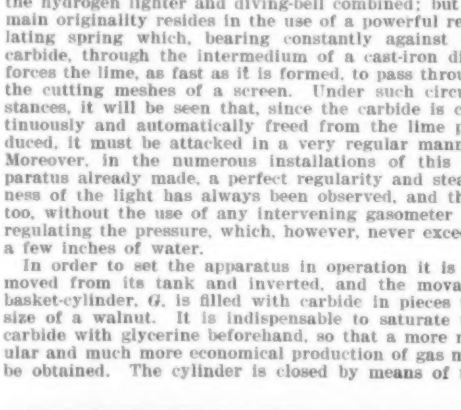
The acetylene generator called the "Polar Star," illustrated herewith, from La Nature, is exceedingly simple in construction and free from any danger, since the gas can never accumulate therein. It occupies a very small space, inasmuch as a generator capable of yielding from 17.5 to 21 cubic feet of gas an hour,

GENERAL VIEW OF THE "POLAR STAR" ACETYLENE GENERATOR.

without being recharged, is but about 16 inches in height and 12 in diameter.

This gas generator is based upon the principle of the hydrogen lighter and diving-bell combined; but its main originality resides in the use of a powerful regulating spring which, bearing constantly against the carbide, through the intermedium of a cast-iron disk, forces the lime, as fast as it is formed, to pass through the cutting meshes of a screen. Under such circumstances, it will be seen that, since the carbide is continuously and automatically freed from the lime produced, it must be attacked in a very regular manner. Moreover, in the numerous installations of this apparatus already made, a perfect regularity and steadiness of the light has always been observed, and that, too, without the use of any intervening gasometer for regulating the pressure, which, however, never exceeds a few inches of water.

In order to set the apparatus in operation it is removed from its tank and inverted, and the movable basket-cylinder, *G*, is filled with carbide in pieces the size of a walnut. It is indispensable to saturate the carbide with glycerine beforehand, so that a more regular and much more economical production of gas may be obtained. The cylinder is closed by means of the



INTERNAL VIEW OF THE APPARATUS.

disk, *P*, which forms a cover that is fastened in place by a bayonet catch. The cylinder is secured in the apparatus by depressing the spring, *R*, and the generator is then placed in its tank, which is filled with water up to the level, *N*. The water then rises in the conical part up to the screen, *JJ*. Since the upper cylinder, which contains the basket of carbide, forms a closed vessel, the water cannot pass beyond the screen, *JJ*, at the surface of which the attack of the carbide begins. The gas formed flows to the piping after passing through the purifier, *O*, while the lime, forced downward by the spring, falls diluted to the bottom of the tank, thus always leaving new carbide in contact with the water without any spongy agglomeration of wet lime.

The production of the gas is dependent upon the consumption of the burners since, as soon as a few bubbles in excess are formed, the water is at once forced back from the screen, *JJ*, and the production ceases.

Now that the truly chimerical fears of danger that acetylene gave rise to a few years ago are a thing of the past, and that the use of this gas of so intense a luminous power is tending to become more and more widely diffused for the lighting of rural districts, small shops and open-air work, this simple, but strong generator will be capable of rendering great services, both in city and country, since the installation of it is, so to speak, instantaneous and its transportation is exceedingly easy. In order to obtain a large production of gas, several generators are connected upon the same line of pipe. The generators can then be made to operate all together or separately, according to requirements.

AN ANALYSIS OF AN OLD RAIL.

Mr. Thomas Andrews has for years been known as studious investigator of steel rails. In a recent number of The Engineer he gives a report of a physical, chemical and microscopic study of a rail taken out of the main line of a British railroad. This was a Bessemer rail which had been in service for fifteen years. It weighed originally 82 pounds per yard; the worn rail had been reduced by wear and corrosion to about 64¾ pounds per yard. It has lost 1.15 pounds per yard each year of its life.

The chemical analysis appears to have been very careful. A section at the end of the rail was analyzed, analysis being made of the head, the foot and near the junction of the head with the web. The same three sets of analyses were made at 12 feet from the end of the rail. All of these showed considerable differences, indicating local segregation. The carbon ran from 0.33 up to 0.36, being highest in the neck; the silicon varied from 0.098 to 0.118; the manganese ran from 0.396 up to 0.468; the sulphur ran from 0.185 to 0.220, and the phosphorus ran from 0.118 to 0.136. Here again the highest determination was found at the junction of the head and the web.

The wear of the top of the rail had nearly cut into the local segregated area, and Mr. Andrews thinks that the rail would have broken soon, for that reason. This he considers a fruitful source of danger in old rails, and he calls attention to it repeatedly in the course of his paper. Not only are the sulphur and phosphorus highest in this region, just at the lowest part of the head, but the high-power microscopic examination showed there "innumerable internal micro-flaws which had reduced the strength of the rail to an unknown extent." The existence of impurities is regarded as the chief cause of this condition.

While the silicon was high the manganese was low, as was the combined carbon, and the carbon and the silicon had segregated locally at the neck. The sulphur was more than double what should be found in a good rail, as was the phosphorus. It is thought that the rail lasted as long as it did only because of the "comparatively low proportion of the carbon and the manganese."

In the physical tests the elongation was 8 per cent in the specimen taken from the head of the rail and 9.5 per cent from the bottom of the rail, the distance between gage points being two inches. The reduction of area was 11.6 per cent. The sample from the head of the rail broke in the tensile test at 34.44 tons, and the sample from the bottom of the rail at 34.52 tons; or at 77,146 and 77,325 pounds respectively.

Mr. Andrews concludes, and probably with justice, that the presence of the micro-flaws just below the present wearing surface of the rail formed a very dangerous element, which would undoubtedly have soon led to fracture had it not been taken out of service.

THE PROPOSED INTER-OCEANIC CANAL.*

The proceedings of the United States Senate on June 19, their subsequent acceptance by the House of Representatives, and the then inevitable withdrawal of the Nicaragua route from the sphere of practical politics, have necessarily, in large measure, modified the scope of the present article as originally planned. Pending the decision of Congress, primary interest naturally attached to a comparison of the most salient characteristics of the two projects submitted to the choice of the United States—the one, the Nicaragua route, with all its admitted and latent dangers; the other, the partly-made, now thoroughly understood, Panama enterprise. To-day, however, such a comparison is relatively of less importance, and we shall consequently limit our attention, as far as possible, to those considerations which more closely affect the value of the completed enterprise to the commerce of the world. Such comparisons as we shall suggest will not be altogether superfluous, inasmuch as they will show how serious in effect might have been an unwise choice, not only to the reputation and finances of the United States, but to the interests of the entire maritime world.

There is nothing phenomenal about the long-standing predisposition of the people of the United States in favor of the Nicaragua route. The American nation is not the first to have been misled by erroneous deductions based upon half-truths and partial investigations, and to have then drifted into the belief that patriotism and persistent partisanship are synonymous. Happily, in the present instance, there has been no serious result, other than a few months of unnecessary delay, and these have not been altogether wasted, inasmuch as opportunity has been afforded for discussion tending to unanimity even on issues heretofore regarded as hopelessly irreconcilable. Many reasons have been given for the change which has recently taken place in American opinion on the question, and for the readiness with which the people of the Union have accepted as decisive the Senate's action. With those having reference to internal politics we have no concern. They have no doubt exercised considerable influence, but the dominating considerations have undoubtedly been technical and economic.

At the outset, the Nicaragua scheme appeared to offer many natural advantages, and its vastness and the idea that a Nicaragua canal from start to finish would be the work of Americans appealed with peculiar force to the national genius and imagination. Gradually, however, doubts accumulated as to whether problematical

* The Engineer.

glory might not be purchased at too big a price; whether greater profit, from every point of view, would not attach to a canal more easy of construction, less likely to damage and even total destruction after completion, and, above all, offering greater attractions and advantages to the shipping world. Questions of maintenance and utility are even more important than those having reference to construction alone, and we cannot avoid the reflection that it is scarcely to the credit of British shipowners that they have so far completely ignored this aspect of the controversy. It is not too much to say that the adoption of the Nicaragua route, unchallenged by possibility of competition from Panama, would have been fatal to anything like fair rivalry between British and American commerce; and that, for the United States themselves, the greater safety and celerity of the Panama passage would make that route preferable, even if a canal over it involved double cost instead of less cost than one which would have invited navigation through the treacherous swamp sections immediately east of Greytown and the dangerously sharp curvatures of the canalized San Juan.

It is not pleasant to learn, on such authority as the Liverpool Steamship Owners' Association, that during the ten years ended 1900 no less than 32 per cent of the carrying trade of the United Kingdom with foreign countries was in the hands of foreign vessels, the respective tonnages per year averaging 40,860,575 and 18,887,028. This trade is steadily increasing, the tonnage of 1900 having been 33 per cent greater than that of 1891, but of this increase only 37 per cent can be those credited to British vessels, as against 63 per cent to flying foreign flags. Competent authorities have during many years animadverted upon British neglect of the markets of Central America and of the western littoral of South America, two fields of great importance in the near future, and which will call for very serious attention or require to be wholly abandoned to more pushing rivals when, through the medium of the isthmian canal, trade routes and sailing distances in nautical miles are thus revolutionized:

	Liverpool via		New York via		New Orleans via Panama Canal
	Magellan Straits	Panama Canal	Magellan Straits.	Panama Canal	
San Francisco	14,084	8,068	13,714	5,299	4,608
Panama........			11,050	1,925	
Guayaquill.....	10,722	5,608	10,450	2,864	2,263
Callao........	10,072	6,098	9,800	3,359	2,758
Iquique	9,591	6,760	9,221	4,021	3,420
Valparaiso	8,831	7,369	8,450	4,630	4,029
Coronel..........	8,500	7,577	8,130	4,898	4,237
Yokohama......	11,640 (a)	12,574	13,564 (a) 9,457 (b)	9,835 (b)	9,214 (b)
Hongkong......	9,731 (a)	14,483	11,655 (a) 11,366 (b)		
Shanghai........			12,514 (a) 10,507 (c)	10,883 (c)	10,284 (c)
Manila	9,677 (a)		11,207 (c)	11,585 (c)	10,984 (c)
Sydney.........	12,234 (a)	12,591	13,658 (f)	9,852 (d)	9,251 (d)
Adelaide.........	11,151 (a)		12,575 (f)		
Melbourne......	11,659 (a)		13,083 (f)	10,427 (e)	9,826 (e)
Wellington......	12,949 (a)	11,631	11,414 14,333 (f)	8,892 (d)	8,291 (d)

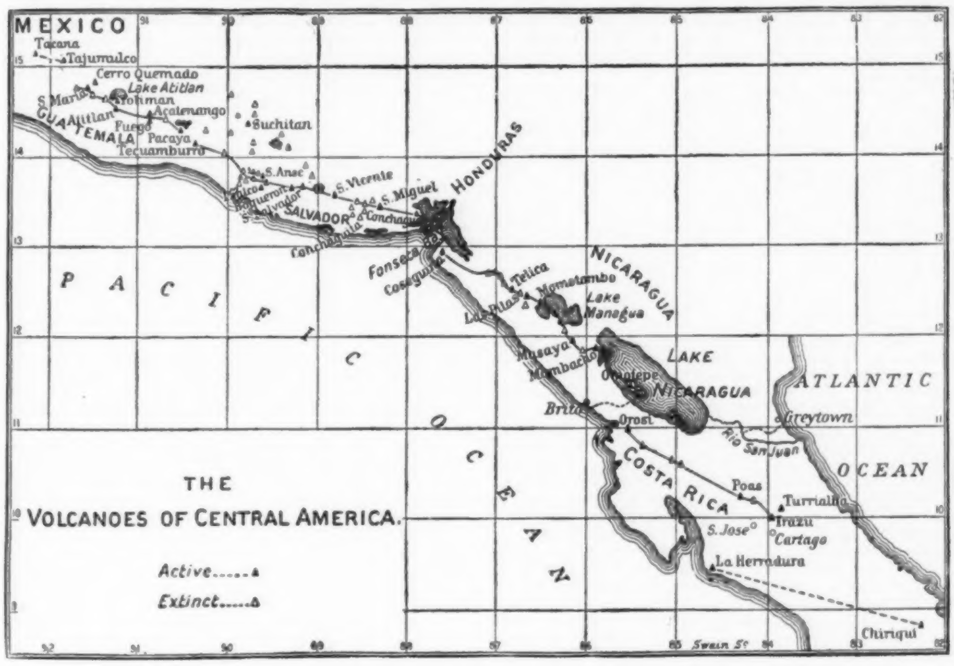
(a) via Suez Canal and usual ports of call; (b) via San Francisco; (c) via San Francisco and Yokohoma; (d) via Tahiti; (e) via Tahiti and Sydney; (f) via St. Vincent and Cape of Good Hope.

From the above table it will be observed that the distance from Liverpool to Coronel, the most southerly of the American west coast ports mentioned, and already an important coaling station, will be about 1000 miles less by way of the Panama canal than by the route through the Straits of Magellan; that the route to the nitrate port of Iquique will be shortened by 2830 miles; that San Francisco will be brought nearer by 6046 miles; that for the Eastern and, pre-eminently, the Southern States the new route is shorter than that via Suez for all Asiatic ports; that New York is 3800 miles nearer Sydney and 5440 miles nearer Wellington by way of Panama than via St. Vincent and Good Hope; and that New York will be nearer than Liverpool to New Zealand, Brisbane, Sydney, and Melbourne, about equidistant from Shanghai as compared with the Mersey port, but considerably nearer Northern China, Manchuria, and Japan—all facts not without significance and warning to persons accustomed to look a few years ahead.

Reference was made in our article of June 20 to the possible damage or overthrow of the projected Nicaragua canal by volcanic or seismic agency, and it is to this question and the relative safety of the Panama route from like dangers that we propose to devote a large measure of attention to-day. During recent decades the field for engineering enterprise has widened enormously, until it now embraces practically every region of the world notorious for seismic activity. Nevertheless, it cannot be said that engineers have devoted all the attention which the importance of the subject demands to the consideration of situations and forms of structure likely to be most or least affected by seismic energy. It is possibly not generally known that in many places, for instance, Japan and Ischia, and at Manila, there exist regulations having a direct bearing on the question, prohibitive of the erection of dwelling places within certain areas of loose soil or prescriptive of the character of foundations which may be used. These rules depend generally upon recognition of certain now well-established facts—that seismic energy is most marked along the steeper flexures in the earth's crust, in localities where there is evidence of secular movement, and in mountains which are geologically new; that steeper sloping ground and steep slopes covered with alluvium are dangerous situations for constructions of any description, and that wet, marshy ground, which is popularly supposed to absorb earthquake action, is pre-eminently a bad foundation. It is true enough that the period of motion is extended in such ground, as has been pointed out by Prof. Milne and other authorities, and repeatedly proved by experiment, but any advantage thus gained is more than counterbalanced by the great increase in amplitude. Having regard to these facts, the notorious seismological reputation of the Central American isthmus, and the descriptions we have given of the Atlantic and San Juan sections of the Nicaragua canal projects, readers will learn without surprise that more potent perhaps than any argument used in the recent campaign of conversion in the United States was the well-grounded fear that the work, however admirably planned and constructed, might prove but a toy to be broken by the often ruthless hand of Nature.

In a review of the interesting volumes containing the final report of the Nicaragua Canal Commission which appeared in The Engineer of February 22, 1901, we referred unfavorably to the comparatively brief mention with which this question was dismissed. Fortified by the decidedly optimistic report of Dr. Charles Willard Hayes, of the United States Geological Survey, fissure might open which would drain the canal, and, if it remained open, might destroy it. This possibility should not be erected by the fancy into a threatening danger. If a timorous imagination is to be the guide, no great work can be undertaken anywhere. It is the opinion of the Commission that such danger as exists is essentially the same for both the Nicaragua and Panama routes, and that in neither case is it sufficient to prevent the construction of the canal."

Concerning these final sentiments, there exists, and will doubtless for long time continue, considerable divergence of opinion. Had Nicaragua been the sole



VOLCANOES AND THE INTER-OCEANIC CANAL.

who had adopted with approval the deduction of Major C. E. Dutton in 1895 that "the risk of serious injury by seismic influences is so small that it ought to be neglected," the Commission arrived at the following conclusions:

"In the northwestern part of Nicaragua slight earthquakes are frequent. Scarcely a month passes without one or more being noticed. The center of these disturbances is always near the line of the Nicaraguan volcanoes. This country is geologically very recent. The great seismic disturbance which caused this upheaval has nearly passed. Nearly all the volcanoes are extinct; only two or three are still smoking. It is believed that this is an era of subsidence, and that earthquakes and other seismic manifestations will continue to grow lighter, and finally cease altogether. Again, the canal route is entirely south of the earthquake area. In the historic period there have been no earthquakes in the canal region of sufficient violence to injure canal structures. It is believed that the danger from earthquakes here is now no greater than in any other sea-coast region."

The later Commission has referred to the question in not very dissimilar terms, but with certain noteworthy admissions:

"It is possible and even probable that the more accurately fitting portions of the canal, such as the lock gates, may at times be distorted by earthquakes, and some inconvenience may result therefrom. That contingency may be classed with the accidental collision of ships with the gates, and is to be provided for in the same way, by duplicate gates. It is possible also that a

available route for the trans-isthmian canal, we might, even with full consciousness of the enormous risk involved, have recognized as practically inevitable the proposed bold defiance of Nature. But there has always been an alternative route, admittedly superior on the great majority of other counts, which required to be very seriously considered in relation also to this question. Is it not a fact that the potential dangers from volcanic and seismic disturbance, so threatening in the case of the Nicaragua route, will be, comparatively speaking, absent from the Panama line? We are told by most of the experts, qualified to speak with authority on the question, that this is the conclusion to which their studies have directed them, and we now propose to recapitulate briefly the arguments upon which it is based.

Although earthquakes and volcanoes may not bear to each other the relation of cause and effect, or vice versa, there is little doubt that they represent different manifestations of the same subterranean forces, and that the former are more frequent, and, as a rule, more destructive, in volcanic countries than elsewhere. This is certainly the case as regards the Central American isthmus, essentially a volcanic region, and of which no part can be described as surely exempt from earthquakes. Here at least, and other portions of the world might be likewise mentioned, we fail to find justification for the long-accepted doctrine that volcanoes are safety valves which abate the violence of earthquakes in their vicinity.

To the volcanic character of the region, the accompanying maps of the volcanoes of Central America, for

VOLCANOES AND THE INTER-OCEANIC CANAL.

which we are indebted to the labors of Dr. Sapper, a German scientist, bears abundant testimony. With its aid, and that of the second map, we hope to be able to indicate within comparatively narrow limits of space, the very real, not fanciful, dangers to which a ship canal, constructed almost in the heart of one of the disturbed districts, would necessarily have been exposed. It should be added that for many essential facts and conclusions acknowledgement is due to the writings and researches of Prof. John Milne, late of the Imperial College of Engineering, Tokyo; M. de Montessus de Ballore ("Memoires de la Société de Sâone-et-Loire, Dijon, 1888," and "Memoires da la Société Alzate, 1898"); M. Marcel Bertrand, Professor of Geology at the Ecole Nationale Supérieure des Mines, Paris; General Henry L. Abbot, U. S. A.; and M. Philippe Bunau-Varilla, formerly Engineer of the Panama canal.

It will be observed, upon reference to the maps, that the series of Central American volcanoes does not form a single range, but is divided into three distinct chains, viz., those of Guatemala, San Salvador, and Nicaragua-Costa Rica; and that each of the points where there occurs a break is marked by the existence of a lake or kindred depression. Thus the Guatemalan series ends with Lake Pacaya, that of San Salvador at Fonseca Bay, that of Nicaragua about the middle of Nicaragua Lake, and that of Costa Rica with the basins of Carthago and San Juan. Chiriqui, to the south, very possibly indicates the existence of another less important volcanic ridge, but the last recorded eruption at Chiriqui occurred in the sixteenth century, and for more recent manifestations of volcanic activity in this region one must go to the Lesser Antilles and the Colombian Andes (Tolima), 1590 miles to the east or 750 miles to the southeast. All the depressions to which reference has been made are incontestably of volcanic origin, and emphasize the significance of the respective breaks in the great mountain chain and the exceptional importance of the shocks and eruptions which have followed the respective lines. Of these, mention of few instances will suffice. The Guatemalan chain is dominated by Fuego, of which there have been no fewer than fifty-seven eruptions since 1880, and is the line favored by the great earthquakes which have five times completely destroyed the city of Guatemala, and as recently as April last laid in ruins eight cities, entailed the loss of from 900 to 1000 lives, and devastated the richest and most flourishing departments of the Republic. The shocks appear to have commenced on April 8 and continued until the 24th, those of the 18th proving most destructive, for they practically razed to the ground Quezaltenango, San Marcos, Solola, and other towns, damaged all the machinery on the plantations in the principal coffee-growing districts, and were felt over large areas of Guatemala, Eastern Chiapas, and Western San Salvador and Honduras. These earthquakes appear to have been felt as far away as Hawaii, and to have been followed by a very destructive eruption of Tocano, one of the most southern of the Mexican volcanoes. Fonseca Bay is encircled with volcanoes, and on its shores occurred in 1835 the eruption of Coseguina, after Krakatoa the greatest of the century. The Nicaragua line was destructively shaken throughout its entire length in 1844, and in June, 1883, witnessed an eruption of Ometepe, accompanied with such copious streams of lava that the entire island was covered and has since been uninhabitable; while the basins of Cartago and San Jose at the feet of Turrialba and Irazu, are notorious for seismic movements of frequency and violence.

There exists, therefore, a striking homology between the interruptions of the four trunk lines; in each case there are a break in the volcanic range, a large basin of depression, and pronounced volcanic or seismic phenomena. Each is evidence of a transverse fracture, and experience gathered from at least three shows that they are lines of greatest weakness and danger. Naturally enough, there are corresponding faults, complete or in outline, in the mountain ridge; the first and fourth have proved of service to man in railroad construction; the second, that of Fonseca, admits the waters of the ocean between the coast chain, while that of Nicaragua has brought about the lowest level of the region between the two oceans. Volcanic activity, in short, has half opened the way for water communication between Atlantic and Pacific, and possibly, at no distant date, might have undone its own work.

Reference to Dr. Sapper's map will show that although the transverse clefts to which allusion has been made are the most important, they are not the only ones. It is, consequently, of interest to note whether similar deductions can be drawn from the lesser examples. Midway between each of the three first ranges, those of Guatemala, San Salvador, and Nicaragua, there are breaks which, without interrupting the volcanic chain are marked by a slight deviation in the line of summits; and as this line is not absolutely straight, the deflection would probably not be of great moment were it not in each case accentuated by the presence of a volcanic lake. These lakes, Atitlan, in Guatemala; Ilopango, in San Salvador, and Managua, in Nicaragua, have all been the scenes of volcanic activity. Atitlan is at the foot of the volcano of the same name, which, after Fuego, is the most dangerous of Guatemala; Ilopango is situated between two active volcanoes, San Salvador and San Vicente, and a new volcano formed in its midst as recently as 1880, while it appears to be on a seismic line, which has ten times since the sixteenth century involved the destruction of the city of San Salvador; and Managua is at the foot of Momotombo, and has in its midst the volcano and islet Nindiri, which has been in eruption and suffered seismic shocks in 1775, 1856, and 1858. Momotombo was in eruption in March last.

Statistics and seismological records are of emphatic worth in establishing the conclusions to which we shall presently refer. There seems even considerable justification for the assertions of many authorities that the volcanic wave is steadily moving toward Nicaragua, and may at no distant date assert itself there with the violence lately observed in Guatemala. It has been calculated that of the great eruptions and earthquakes recorded before the nineteenth century 45 per cent belonged to Guatemala, 35 per cent to San Salvador, and 20 per cent to Nicaragua, but that in the last century the respective proportions were 30, 45, and 25 per cent, showing a displacement of the activity southward. We are not disposed to rely very much upon these figures, but there seems little doubt that while within comparatively few decades several volcanoes have become extinct in Guatemala, no such phenomenon has been noted in the more southern regions, but that, on the contrary, at least three new active volcanoes have come into being—Izalco in 1870, Ilopango in 1880, and Las Pilas in 1850. Moreover, it seems that at San Juan de Costa Rica, the seismographic station near the line of the proposed Nicaragua Canal, no fewer than fifty seismic movements, all coming from the projected route, were recorded during 1901, twenty-seven being classed as "shocks," and seven as "strong shocks," while two others, though defined as "light shocks," were sufficiently alarming to cause people to rush from their houses. On the other hand, records of the city of Panama for the same period noted but five movements, all coming from the east or northeast—one "sensibly felt," three "very light tremors," the fifth so slight as to be questionable.

There was possibly no physical connection between the Guatemalan earthquake and the Martinique and St. Vincent disasters, although one of our maps suggests a contrary conclusion. Between the lessons afforded by all three as to seismic possibilities, there is, however, a very logical affinity. A volcanic eruption in the comparative vicinity of such a work as the isthmian canal might not have more serious effects than the Coseguina catastrophe, which converted into night two complete days, covered with cinders a circle of 1860 miles diameter, filled up ravines, and obstructed with scoria all the harbors of Guatemala. It, however, was accompanied neither with earthquake nor a seismic wave, and these are the dangers most to be dreaded in connection with great constructive works. To estimate the possible effects of earthquakes is yet a very uncertain matter, but this seems a not inapt formula, that they produce in an immediate manner the consequences which would be brought about, in a time more or less long, by the gradual operation of ordinary forces. Masonry dams, therefore, solidly founded and well-constructed, might have relatively little to fear; but the same would not be the case with the high embankments of earth so generously distributed over the suggested Nicaragua route. Minor errors in construction, a minimum of stability, or the least settlement of the foundations, would invite fissures of which the effects might be irreparable. A rupture of the embankments or dams of a canal of such length as was projected in Nicaragua would be a disaster so frightful that even need of having to consider it may be regarded as ample justification for the rejection of the scheme. If a temporary work had been involved, one might have ignored the alleged advance of a volcanic wave, trusted to the slowness of progression, and put faith in the advantages resulting from the mobility of the soil; but when there was question of an enterprise which should endure, it would have been imprudent, to say the least, to have attempted a hopeless combat against forces before which even the greatest and richest of nations are absolutely powerless. More disastrous, however, than earthquake shocks may be seismic waves. That which accompanied the Krakatoa eruption rose to 72 feet at Sumatra, and to 118 feet on the Java coast, while the only known instance in Central America, that of the earthquake of August 4, 1856, resulted in the complete destruction of Omoa, on the Honduras coast. There is really no reason why the latter should remain exceptional, and it must not be forgotten that there have been warnings in the lakes of the volcanic chain. In Lake Ilopango, before the eruption of 1880, the waters rose 4 feet and afterward sank 328 feet; while during the earthquake of 1844, which destroyed the town of Rivas, the level of Nicaragua rose and fell in such a way as to cause immense devastation along its shores. These are but mild indications of the movements which a violent manifestation of seismic force might produce in the waters of the lake relied upon as the only means of feeding the long-suggested Nicaragua canal.

Of kindred dangers in the case of the Panama enterprise there is happily a notable absence. There are no volcanoes in the neighborhood of the canal line, nor has any eruption occurred in the region since the Miocene period. Considerable doubt is cast upon the accuracy of accounts relative to the earthquake of 1621, since which the country has experienced only feeble tremors, many of them due, there is little doubt, to the echo of distant shocks. The depression of the Pacific coast, and particularly in Panama Bay, are not phenomena in course of operation, but already complete so far as regards the existing geological period; while the lines of folds and the distribution following these lines of volcanic or seismic activity show that Panama is situated in a sort of dead angle, or tranquil zone, equidistant from the nearest lines of disturbance, north or south. All recognized facts, in short, lead to the same conclusion, that this narrow portion of the isthmus is the most stable and least menaced region of Central America. Yet, so blinding may be the effects of partisanship, Senator Morgan dauntlessly declared a few weeks ago that, on the count of seismology alone, the situation favored the Nicaragua claims by two to one.

In our next and concluding article particular attention will be devoted to special features relating to the navigation of the accepted route, the maintenance and operation of the latter, and the measures desirable to prevent it becoming a center of infection.

THE PRESERVATION OF IRON BY PAINT.

An important contribution to our knowledge of the comparative value of different preservative compositions for iron has recently been published by L. E. Andés, a well-known Continental writer upon all subjects connected with paint. His tests are too lengthy to be reproduced in detail, and indeed they are not yet finished; but they bring into prominence several facts which often seem to escape notice. It appears that a simple coat of linseed oil, raw or boiled, or some varieties of spirit varnish, are useless as preservatives when the metal is to be exposed to the weather, i. e., to sun, rain and damp air; but that, granted an oil-paint is made up with a trustworthy pigment, the coating will be permanent, and it will not matter much what particular pigment is selected. But the vehicle, or liquid matter, must be essentially linseed oil. On the contrary, if the metal is to be always under water, especially fresh water, oil paints are valueless—except red lead in boiled oil; and the proper protective is one of those spirit varnishes which fail in the air. An oil paint which, when tested on glass, seems to indicate permanency under water, is shown to be devoid of utility when it is applied to iron. Salt water, such as sea water, is less injurious to oil paints than fresh water; and a single layer of white lead in oil withstands a 3 per cent solution of common salt better than several layers of the same paint stand pure water. The best method of protecting iron which has to be kept under water constantly is still being investigated; at present it seems that a priming of red lead in boiled oil followed by some varnish paint is the most satisfactory. For exposure to definitely corrosive influences a spirit varnish composed of some resin and some celluloid gives the most lasting coat, but the behavior of this material in air has not yet been studied.

PUBLIC LECTURES AT THE AMERICAN ASSOCIATION.*

By MARCUS BENJAMIN, Ph.D.

It has long been customary for the American Association to present at its annual meeting one or more public lectures complimentary to the citizens of the city in which the meeting is held. These lectures are usually delivered in the evening, and the speaker is one chosen from among the members of the Association for his eminence on the subject which he offers, and which is naturally of a popular character.

At the recent Pittsburg meeting there were three evening lectures, all of which were of such general interest that abstracts of each are here presented. The first of these was on "The Prevention of the Pollution of Streams by Modern Methods of Sewage Treatment," and the speaker was Dr. Leonard P. Kinnicott, of the Worcester Polytechnic Institute, whose extensive studies on sewage work have gained for him the reputation of being the best authority on that subject in the United States.

Sewage, said Dr. Kinnicott, can be defined as the water supply of a city after it has been used, containing the solid and liquid excreta of the population, household waste, the washings of the streets, and the refuse of every branch of industry. On the average the sewage of a city is pure water containing seven pounds of waste in 1000 gallons. It also contains approximately 150,000,000 to the liquid ounce of these microscopic organisms called bacteria. In the perfect treatment of sewage the bacteria as well as the refuse matter must be removed.

The perfect treatment is the removal of micro-organisms as well as city waste, changing sewage back into a water supply if possible, so that after the treatment it will be offensive neither to the sight nor smell. The earliest method of disposal was to carry the waste into the ocean or nearest stream. This is known as dilution, and is allowable for cities on the sea or for those on streams in which the flow is one hundred times as large as the sewage. But very few cities are situated so fortunately, and the purification of the sewage must be considered as imperative as obtaining pure water.

This is one of the great sanitary problems of the times, and the six principal processes by which the necessary purification is obtained to a greater or less degree are as follows: Sewage farming, chemical precipitation, intermittent filtration, contact bed treatment, septic tank treatment, and continuous filtration.

Sewage farming is the applying of the sewage to cultivated land. Chemical precipitation consists of adding certain chemicals to the sewage to remove or throw down the polluting substances. The other four treatments, known as the modern methods, are all based on the fact that the micro-organisms or bacteria always present will, under proper conditions, destroy all obnoxious substances contained in the sewage. The first two are methods of the past, and the others are the ones now in use.

Intermittent filtration consists of passing sewage through sand, by which conditions favorable to the growth, retention, and action of bacteria are brought about, and the obnoxious substances are destroyed by the aid of these microscopic organisms. The credit of showing that sewage could be purified on a practical scale by intermittent filtration through sand belongs to the Massachusetts Board of Health. Their experiments, published in 1890, showed that all that was necessary to destroy organic matter was to provide conditions favorable to the action of bacteria. Sand was found to be a suitable material through which the matter could be passed and still preserve the bacteria by having air spaces about them.

This was accomplished by underdraining the sand, and allowing the sewage to flow on it only 6 hours out of 24. By this process nearly 75,000 gallons can be filtered in a day on an acre of sand, so that the water runs off clear and bright, and can be emptied into a small stream without fear. It is undoubtedly the best method for cities which have in their neighborhood large areas of sandy soil, but is not applicable to those which would be obliged to convey sand from any distance.

The septic tank is a modified cesspool, and it is interesting to note that the old-fashioned cesspool, which only a few years ago was regarded as the breeder of all manner of ills, is now regarded by sanitarians as a most valuable adjunct in the disposal of filth. A septic tank is simply an open or closed tank, through which the sewage runs continually, but at a rate which requires it from 12 to 24 hours to pass through. By allowing the sewage to remain in the tank out of contact with the air, it "works," or putrefaction takes place by the enormous increase of the bacteria. The sewage bacteria thus remove or change the polluting substances and give a product no longer crude sewage, but a sewage in which a large amount of the polluting substances have been removed or changed into gas. A septic tank in action gives almost a boiling appearance to the tank in hot summer

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

weather. The gas which escapes, often 75 per cent, can be conducted off and used as fuel or an illuminant. By using the septic tank in connection with the intermittent filtration system, both species of bacteria, ærobic and anærobic, are permitted to work and an amount five times as great as by the former plan alone can be treated in the same length of time.

The contact bed treatment is the result of experiments on London sewage. The sewage is applied rapidly, being run into a water-tight bed filled with coarse-grained material, such as cinders, coke, or broken stone, and retained in the bed a given number of hours, after which it is run off again rapidly. The action of this method depends upon the presence of ærobic bacteria. If the filling material in action is examined every piece is found to be coated with a slimy growth. It is composed chiefly of bacteria, and it is on its presence that the efficiency of the bed depends, up to a certain point. If this point is overreached, the void spaces between the particles of filling are choked and the liquid capacity is decreased. This is the one objection to the bed, as it is held that the limit cannot be regulated by artificial means.

Continuous filtration is the method which is now attracting the greatest attention in England. It is simply an attempt to further increase the amount of sewage which can be treated in a given area, so that from 2,000,000 to 3,000,000 gallons of matter can be passed over an acre of sand instead of only 500,000 gallons. The methods are all based on the idea that if air is supplied to the bed at the same time as the sewage and the filter is of such construction and so drained that fresh air continuously remains in the filter, there is no necessity for the periods of rest observed in intermittent or contact-bed methods, as the only objects of these rests is to supply sufficient air to the bacteria.

Undoubtedly continuous filtration has certain merits, especially that of being able to treat larger quantities of clarified sewage on a given area than any other bacterial process, but even if it accomplished all that is claimed it is a process that requires a great deal of oversight and attention.

Further, I do not see how these filters can give satisfactory results in very cold weather unless the sewage is artificially heated, owing to openness of construction. I should expect in a climate approaching that of our Northern States the whole filter would often be a mass of ice.

Regarding the various methods I have mentioned, it may be said that sewage farming as a general method of sewage treatment is not practicable, that chemical treatment only removes a part of the polluting substances in the sewage. It is a partial or preliminary treatment, advisable only in cases where sewage contains germicidal substances, thus preventing the use of the septic tank.

That intermittent filtration is the best of all methods for the treatment of sewage of cities where sand can be easily and cheaply obtained, though the amount of sewage that can be treated per acre per day is not over 75,000 gallons, unless the septic tank is used in connection with the process. That the septic tank process is a most valuable adjunct and almost an essential part to all bacterial methods of sewage treatment.

That the contact method is not adapted and should not be used for the treatment of crude sewage, but can be considered a very satisfactory method for the treatment of sewage after it has undergone putrefaction in the septic tank.

That continuous filtration, though capable of treating much greater quantities of sewage per acre than can be done by any other method, is still in the experimental stage.

A second lecture, on "The Development of American Commerce—Past, Present, Prospective," was delivered by the Hon. Oscar P. Austin, who is Chief of the Bureau of Statistics in the Treasury Department, Washington, and therefore specially competent to discuss his subject. He said in part:

The foreign commerce of the United States divides itself into three distinct periods—that prior to 1870, when the growth was comparatively slow and the imports usually exceeded the exports; that following 1870, in which the growth was more rapid and the exports usually exceeded the imports; and that of the last decade, in which manufactures form an increasing share of the exports and manufacturers' materials an increasing share of the imports.

Following the construction of the transcontinental railway, completed in 1869, came the extension of other lines through the great Mississippi Valley and the South, and this resulted in the opening of the great agricultural, forest, and mineral areas. Agricultural production has more than doubled and manufactures more than trebled as a result. The value of farm product increased from less than $2,500,000,000 in 1870 to about $3,750,000,000 in 1900—though in each case the figures of value fail to show the full growth in production, owing to the fall in prices of nearly all articles meantime. The production of coal, a prime necessity in manufacturing, grew from 33,000,000 tons in 1870 to 290,000,000 in 1901; pig iron from less than 2,000,000 tons to over 13,000,000 tons. Meantime the railways have grown from 52,000 miles in 1870 to practically 200,000 miles at the present time, and rates for rail transportation have fallen to about one-third the rates of 1870. The value of our exports in 1870 was $393,000,000; in 1901, $1,487,000,000; our imports in 1870 amounted to $436,000,000; and in 1901 to $823,000,000.

The causes of this development in exports are to be found in the fact that the United States is the world's largest producer of the great articles required by man for his daily life. It must also be expected that our imports will continue to grow. The reasons are coincident with our growth in manufactures. While the United States is the world's greatest producer in the chief elements required in manufacture, it does not produce certain articles of tropical and sub-tropical growth of which the manufacturers are requiring constantly increasing quantities, such as raw silk fibers, Egyptian cotton, India rubber, and many other articles of this character. This fact of our growing dependence upon the tropics suggests that the events of the past four years have been of advantage, in the fact that they have brought under the American flag an area capable of producing a large share of these tropical requirements, and taking an equal quantity of our products in exchange therefor.

The final one of these three lectures was by Robert T. Hill, of the United States Geological Survey, and was through the courtesy of the National Geographical Society. It will be remembered that Mr. Hill led an expedition to Martinique sent out by the National Geographical Society a few weeks since, and his subject, "The Recent Disaster in Martinique," was therefore one of particular interest.

In beginning he described Mont Pelée as a simple volcanic cone which has been growing above the bottom of the sea since early tertiary time, surmounted by a volcanic crater that has existed in its present position since the island was first born. He showed by means of lantern slides the central summit crater, the bowl-shaped basin, the radiating steam, valleys cutting the circular mountain into numerous segments, the truncated coast, and the fatal segment, in which St. Pierre was located, which constituted the amphitheater of death.

In the beautiful city of St. Pierre, as it was before the eruption, the cliff-bound topography constituted an important point in the causes that led to its destruction. The "Dixie," on which he made his trip, found Martinique on her arrival at Fort de France as green and beautiful as though nothing had happened. From that city it was an hour's journey along the picturesque and still unscathed coast to the city of St. Pierre. Then, rounding a cape, the panorama of death was exposed.

The crater was still emitting clouds of smoke, as well as the lower vent upon its west side, from which the fatal cloud probably came that caused the destruction of the city. The cloud which destroyed St. Pierre was only one of a series of events which had been taking place for a month or more with gradually increasing intensity.

The phenomena of the fatal eruption were then categorically enumerated, including the preliminary air movements and detonations, the density, weight, motion, and direction of the fatal cloud, and the heat, steam, lack of incandescence, the flame, and the lightning which accompanied it. The death dealing agencies, outgoing and returning force, exhaustion of air, flame, probable explosions, and the succeeding rain of mud and pumice which followed, were all described and can be found very fully given in the latest issue of the National Geographical Magazine.

In closing he discussed the extent and phenomena of the devastation and its causes.

Concerning the lessons of Mont Pelée, he said: The volcano as a whole has not contributed much to the previously existing theories of volcanism, but has given us some new and valuable hints that show some probability of volcanic action being caused by disturbances within the earthen magna itself, causing it to rise toward the surface, rather than surface water descending to it through pre-made fissures. Mont Pelée may be considered an ancient volcanic mechanism, in which the volcanic force has always slumbered. The recent eruption, which has in nowise changed the configuration of the island, was merely a reopening of the old vents.

COUNTERFEITING AND COUNTERFEIT-DETECTING.*

The success of counterfeiters is not so much due to the cleverness of their work as it is due to the ignorance and carelessness of the general public. A man who is not familiar with the distinctive earmarks on the genuine money of the land cannot be expected to detect the counterfeit presentment of them when they face him on spurious money; so that every man ought to make himself familiar with these distinctive ear-marks of real money—and he must do so, if he would successfully protect himself against the skillful imitations and the cunning devices of the shrewd counterfeiters who infest the land and prey upon this species of popular ignorance.

Steel-engraving is a fine art about which the general public knows next to nothing; and yet the possibility of detecting counterfeit paper money unerringly is bound up in the engraved features of its make-up. Of course, it is not contended that everyone must become a master of the engraver's art before he can successfully detect counterfeit money; but it is contended that he must make himself so familiar with the distinctive features of the genuine machine-engraving on the national currency that he can distinguish it from spurious and imperfect imitations of it. Nor is it a very difficult task. It can be done by anyone who will take the trouble incident to a proper study of the subject. The work executed by the government, as well as that which is executed by banknote companies, possesses great beauty in its art and exact perfection in its execution and finish. It is mathematically and geometrically exact in all its parts, while the spurious work of imitating counterfeiters is necessarily imperfect in these respects.

This is due to the fact that the former is done by machinery, while the latter is done by hand; and to the further fact that hand-engraving, even when aided by simple machinery, can never approach the beauty, exactness and general perfection of machine-engraving. And yet although these very designs have bound up in them the chief safeguards which the government has thrown around our national currency to protect it against being successfully counterfeited, not one man in any ten met upon the streets of our cities, much less the rustic tillers of the soil met upon the rural highways of the country, is familiar with either the character or the object of those beautiful designs which are found upon our national currency. This fact is very aptly illustrated by the tests which are applied by different persons to determine whether a suspected note is spurious or genuine; one looks carefully for pen-holes; another scans it for signs of wear, and another scrutinizes the vignettes, while others examine the paper—not knowing that all of these evidences may be counterfeited successfully or imitated so perfectly as to deceive almost anyone; but very few, if any, apply those real tests which involve the only truly and unmistakably distinctive features of genuine notes. Hence, the alarming success of counterfeiters in passing their spurious products is not so much due to the fact that the excellence of their imitations of these distinctive features of genuine notes is prone to deceive the intelligent observer as it is due to the fact that the general public is ignorant relative to the construction, purpose, character and distinctive features of that difference which distinguishes the genuine from the spurious. Everything on the average national currency note, except the fine lines of engraving, may be successfully counterfeited; but these fine lines defy all impostors. All of the circles, ovals, squares and parallels, as well as the geometrical lathe-work upon which the denominations are usually placed, are composed entirely of a perfect net-work of finely engraved lines, which cross each other at such angles or approach each other at such distances as to produce the desired effect. These finely engraved lines constitute the chief, the distinguishing feature of the government's money-engraving, and they cannot be successfully counterfeited.

It will be noticed in all genuine work that these fine lines can be traced by use of a lens, throughout the figures—not a line being broken, not a line losing itself in another line and not a line showing any irregularity whatever in its course, in its uniformity of curve and width or in its degree of shading. These lines may be either white upon a background of black, green or red; or they may be black, green or red upon a background of white; but they are always exact, always even and always uniform. They are made by a geometrical lathe which was invented by one Asa Spencer and introduced to the public about 1818.

This lathe is a perfect wonder; it produces patterns of almost every conceivable variety in form and figure; but this same fine quality of the lines clings to them in whatever form they may appear. So that, when it is remembered that this uniformity and uniqueness of execution is impossible in hand-engraving, the spurious note falls all to pieces under this test. The striking difference between the genuine and the spurious is very natural from the simple fact that the one is mathematical and exact, while the other is mechanical and necessarily varied. The lathe does not engrave directly upon the note-plate, while the counterfeit engraver does. The lathe engraves upon a piece of soft steel, one-eighth of an inch thick. After this piece of soft steel has been properly engraved by the lathe, the piece of engraved steel is hardened by a peculiar process; then (by means of a powerful machine called a transfer press) a cylinder of soft steel is rolled over the hardened piece of engraved steel in such a manner that the engraving is transferred to the cylinder, which is then hardened; and, from this hardened cylinder, the designs are transferred to the note-plate by means of the transfer press. In this way the work is not only exact—mathematically exact and artistically perfect—but it is always uniform; for this cylinder acts as a perpetual model from which any number of plates can be transferred—each being an exact reproduction, or facsimile, of all the others taken from that same cylinder. Hence all United States notes of any one series are exactly alike in every respect—except the numbers and the signatures. And right there is where the counterfeiter falls down before the practised eye. He must do his engraving directly upon the note-plate—which imposes many insuperable difficulties; the lines cannot be made as perfect as they are in this lathe work, and the general effect of the printing is inartistic in comparison with the impressions taken from lathe-made plates. Even to the naked eye the appearance is more or less dull and sunken, or scratchy; and the figures are sure to be lighter or darker in spots, as the lines are heavier or lighter in places. The use of the lens in such cases discloses the fact that the lines are often broken, varied or irregular, either in size or course. Besides, it being impossible for any hand-engraver to produce two dies exactly alike, it happens that the spurious dies are not only not exact reproductions of the genuine lathe-made dies, but no two of the spurious dies are exactly alike; so that comparison, under the lens, between the dies on a suspected note (if it be spurious) and a genuine note brings out this difference so clearly that very little skill is required to detect and read it.

All the government dies used in printing any given series are exactly the same—all being transferred from the same cylinder, and they must, therefore, be exactly the same in every respect. This impossibility of making two dies separately and independently exactly alike by the hand-engraving process not only prevents the counterfeit dies from being like the genuine, but it also prevents any two counterfeit dies from being exactly alike, since the plates must be separately and independently engraved. But, besides this absence of exactness in the reproduction of the dies, there is another notable feature of difference which is conspicuous for its presence in the genuine and for its absence from the spurious note; and that it is the beautiful, clear-cut, raised impressions produced by the correct and uniform lines of the lathe-work, which the counterfeiter cannot reproduce to save his life.

This machine work is therefore the safest ear-mark there is for detection purposes; but it must be used intelligently. In examining this work on any suspected note, it is a pretty safe way for the examiner to begin at the center of the curvilinear figures and then gradually follow the lines around the circles, one within another, carefully searching for any special defects and for the discovery of any irregularity not patent to the naked eye. And he should also make careful and minute comparisons between the general designs on the genuine note and those on the suspected one.

Sometimes the whole face of a note (except the vignettes and dies) are tinted a pale red or some other color; but examination under a lens discloses the fact that this tint is composed of fine crossed or looped lines, running clear across the face of the note. This is another species of machine work which is but poorly imitated by the most expert counterfeit engraver who has to depend upon his hands. This work, when gen-

* Bankers' Monthly.

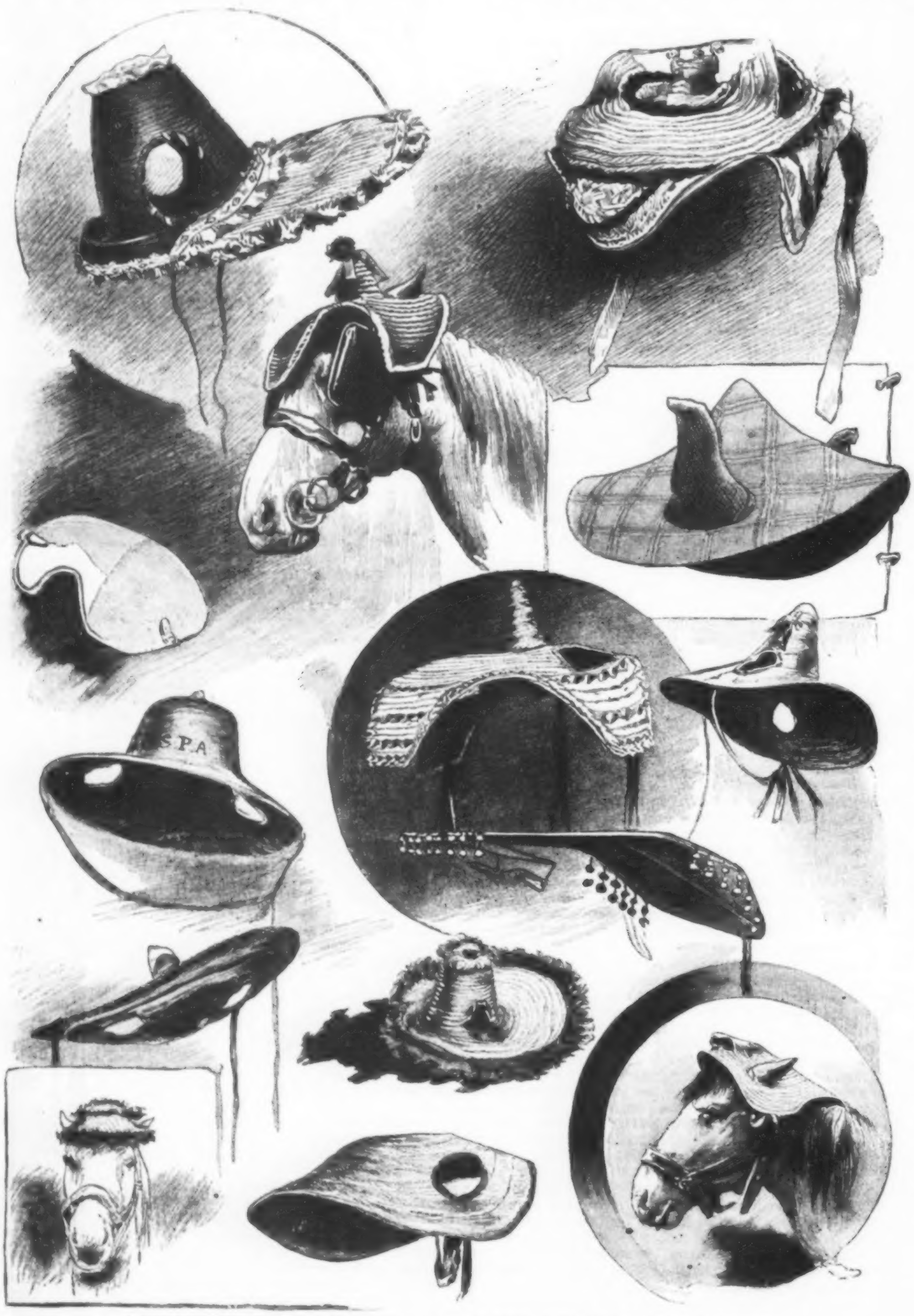
uine, shows the lines to be perfect in execution and in shading, while the spurious note bears evidence of imperfection in both respects.

Parallel lines also afford a check. They are made by a parallel ruling machine, which is governed by an index to regulate the width of the lines, and they are mathematically exact. They are always uniform, always regular and always exactly parallel—conditions which do not obtain when the counterfeiter undertakes to reproduce them by the process of hand-engraving. These parallel lines are used in shading the letters and figures on the genuine notes into a perfectly even pale gray. They are also used to represent a clear sky or water; but crossed lines are used to represent cloudy or heavy skies. In genuine work these lines can always be counted, while such is not always the case with counterfeit notes, as the lines on them are often broken, blurred and irregular.

Some people rely on the vignettes as reliable ear-marks for detection purposes; but they make a mistake in doing so. The vignettes are the most artistic part of the whole note, and they are mostly hand-engraved, even on the genuine notes; so they may be almost perfectly imitated or reproduced—but that is not often the case. The vignettes on the national currency are made by the very finest artists in the country, and they are beyond the successful imitation or reproduction of any one but an artist of the first water; and, since the salaries which such artists can command at legitimate work are too satisfactory for them to resort to the rather risky business of counterfeiting themselves or lend their talents to others engaged in that hazardous outlawry, these would-be imitations are made by rather inferior artists and are necessarily imperfect in many respects. Real vignettes have this advantage over spurious ones: They are never made but once, and are, therefore, uniform and always exactly the same. They are transferred to the cylinder, just as the lathe-work is, and then transferred (by use of the transfer press) from the cylinder to the note-plate, thus using one model all the time; but such is not possible with the spurious vignettes. They must be reproduced, and exact reproduction is very difficult, if not impossible. But, it being noticed that counterfeiters get along better in reproducing outdoor scenes than they do in reproducing portraits, the government has very wisely mingled its vignette work—making them consist of outdoor scenes, historical pictures, portraits and allegorical figures, which it not only becomes difficult for counterfeiters to imitate, but which furnishes a somewhat graduated scale of difficulties for them to surmount.

The engraving test is the best possible ear-mark in the detection of counterfeits, for two very good and sufficient reasons: In the first place, the above-noted differences will always appear as long as counterfeiters have to rely upon hand-engraving, while the government uses machine engraving; and, in the second place, these counterfeiters will always have to rely upon hand-engraving, because machines for the purpose are too bulky and too expensive for them to handle—considerations which will always place machine-engraving beyond their reach. If a man has \$75,000 to \$150,000 capital (the cost of a proper outfit of machinery for this work), he would hardly risk its investment in an illegitimate enterprise which might be swooped down upon at any moment by government officers and utterly destroyed, with the legacy of a life sentence in the penitentiary added. Hence, it may be pretty safely assumed that all the engraving done upon spurious note-plates will always be done by hand, and that this test can always be applied.

Burton T. Doyle.



FROM THE PARIS CONTEST IN SUMMER BONNETS FOR HORSES.

A HORSE BONNET CONTEST.

In order to protect the expensive horseflesh against the action of the sun's rays during the hot season, the owners of business and pleasure vehicles in the large cities are providing their quadrupeds with hats made of strong straw or rush. These hats generally have a brim bent up high and a pointed crown, two openings at the side allowing sufficient space for the animal's ears. The airy head gear is fastened with bows to the neck piece and to the forehead strap of the bridle. Those who are very fond of their horses even place a compress moistened with cold water under the hat, which contributes not a little to the freshness and liveliness of the animal.

For the purpose of obtaining a serviceable and at the same time cheap head-covering for horses the Society for the Prevention of Cruelty to Animals arranged a prize contest in this article. The competition did not fail to arouse the ingenuity of inventive brains; at any rate it was successful in that more than 200 samples were received by the jury, which were exhibited during the last days of May in the rooms of the Circus Medrano in Paris.

The prize was awarded to two models, viz., a rush hat with a ventilation contrivance in the upper part of the crown and a cork helmet constructed by Dr. Mesnard. In the rush hat the ventilation was the novel and useful part, while the cork helmet is merely an adaptation of the customary tropical army headgear to the purpose which the society pursued in its prize contests.

Our illustrations show a selection of these creations, some of which reveal a rather bright fancy. At all events the result of the competition should not be underestimated; it has rendered a service to the cause of the protection of animals and at the same time opened the way for an entirely new branch of industry, viz., ""millinery for horses."—For the above information and the accompanying cuts we are indebted to Illustrirte Zeitung.

SCULPTURE IN NORTHERN CENTRAL SYRIA.*

By Howard Crosby Butler.

It was something of a surprise to the members of the American Archæological Expedition who spent the autumn and spring of 1899-1900 in Northern Syria, to find a number of monuments of sculpture, in relief, of more than ordinary interest; some of them in the deserted towns visited by M. de Vogüé, and some in places which he did not see. The greater number of the reliefs are funeral in character, or, at least, were found in tombs or upon sarcophagi; but two were found upon large rocks standing in the open country, not far from ruins, and one formed a part of the pediment sculpture of a Roman temple.

These sculptures are executed in the native rock, a fine white limestone, easily quarried and cut, but hardening with exposure to the weather.

The first new evidence of the existence of sculpture in Northern Syria was discovered near the northern end of the Djebel Barisha, where we found a beautiful little temple of the age of the Antonines. The site, high on a spur below the summit of the highest mountain of the group, the Kubbit Babutta, is called Burdj Bakirha, and towers above a deserted city, known as Bakirha. The tetrastyle pronaos of this prostyle temple has fallen in a heap of ruins—only one column and a portion of another are standing erect; but its sides and rear, or western wall, are in an excellent state of preservation. In the gable of the west end we may plainly see the figure of an eagle which occupies the middle of the pediment. The eagle stands in the attitude characteristic of the bird of Jove, with wings raised but not outspread. The gateway of the temenos of the temple bears a dedicatory inscription, which shows that the temenos was sacred to Zeus "Bomos," and gives the date 161 A. D. The architectural details of the temple indicate that it is certainly not later than the inscription and may be earlier. The exposed position of this bit of relief sculpture has caused it to weather badly and it is difficult, for this reason, to study the relief in detail; but the pose of the figure and the depth of the relief show it to belong, like the temple, to a good period of Roman art.

Our expedition visited many deserted cities and towns in this neighborhood without finding further evidences of sculpture, until we came to the extensive ruins of Dêhes, where M. de Vogüé found an important inscription which he published. On the southern outskirts of this town we found a narrow entrance to a tomb—a flight of steps cut in the living rock, descending from the level of the surface to a small doorway which opened into a large, square, rock-cut chamber with flat floor and ceiling. One side of the chamber was occupied by the entrance, the other three by deep arched arcosolia—two on each side. Each arcosolium embraced two rock-cut sarcophagi running lengthwise, that at the back of the arcosolium being raised to its full height above the one in front of it. The faces of the sarcophagi, the wall surfaces at the back of the arcosolia, the spandrils of the arches and the narrow piers between them, were all ornamented with reliefs which are in various conditions of preservation.

The faces of the upper sarcophagi, at the back of the arcosolia, are carved to represent Roman couches. The head of each couch is formed by a dolphin with tail in air to give an easy curve, and turned legs are executed in relief at either end. The lower sarcophagi, which have their sides flush with the wall of the chamber, are ornamented with masks and garlands. On the wall at the back of the arcosolia are busts in high relief, one in each, portraits presumably of the men and women who were buried beneath. The spandrils between the arcosolia are variously ornamented. Beginning at the center of the left side as you enter the tomb, we have a group in low relief, a man, spear in hand, in a sort of chariot, battling with a beast of many coils. This group I take to represent the contest between Herakles and the Lernæan Hydra. In the next spandril, which forms an angle at one corner of the chamber, is a man with a long goad driving a yoke of oxen before him. If we accept the former group as representing Herakles and the Hydra, we may recognize in this the same hero with the oxen of Geryones. The next spandril, that in the middle, facing you as you enter, contains a long-necked bird with outstretched wings, in the familiar attitude of

* Abstract of paper read before Archæological Institute of America. By courtesy of the Princeton Bulletin.

the Phœnix. The lower portion of the relief has been destroyed so that we could not discover if the bird sprung from flames, but his pose and the crest which rises at the back of his head are very suggestive of this emblem of immortality. The remaining spandrils are so badly weathered that it was not possible to determine the subjects of their reliefs. On the face of the central pier on the left hand, below the group which we have designated as Herakles and the Hydra, is the well-executed figure of a lion, framed in a set of moldings. The pier below the Phœnix relief is adorned with a large head of Medusa, above a squat and ugly genius badly weathered. On the front wall of the chamber, to the right of the entrance, is a poorly executed figure, in relief higher than that of the spandrils, but not so high as the busts. It represents a man, a little less than a meter high, wearing a long robe with large sleeves; in his right hand he holds a staff, his feet seem to be incased in shoes, but the figure in no way compares with the other reliefs. The lower portions of this relief are strikingly like those of a fragment of a stele found at Kefr Finsheh, a few miles distant, which bears an inscription with the date 189 A. D.

It is difficult to speak in detail of the style or technique of these sculptures, for the water which for centuries has percolated through the limestone roof of the chamber has left a deposit of lime upon the surface of most of the reliefs and has worn away others. None of the work would seem to represent a high stage of development of the art of sculpture, but it is all interesting in this particular locality. The busts would seem to have been stiff and crude even at their best, though it may not be fair to pronounce judgment on heads from which the features have entirely disappeared. The spandril reliefs too are badly weathered, but the figures on the piers, which were not so much exposed to the dripping water, and the decorations upon the lower sarcophagi, show some real merit. The small lion is excellently drawn and well executed, while the masks and garlands are quite equal to the best work of a similar character in Italy itself during the second and third centuries. These sculptures, those of Burdj Bakirha and Dêhes, are the only monuments of this art which have been discovered in the Djebel Barisha. The reliefs from the tomb of Claudius Sosander, published by M. de Vogüé, are the only sculptures known in the Djebel il-A'la.

Let us now proceed to the south, to the Djebel Rîha, where M. de Vogüé found the Agnus Dei relief. We had spent some time in this region before finding any more remains of sculpture than M. de Vogüé had seen. In one town from which he published a number of buildings, we found a suggestion of the sculptor's handiwork. This was in Ruwêha, upon the lintel of the doorway of a house, which, by comparison, one would assign to the earlier period of archtectural activity in the region. The design (Fig. 1) is a relief representing, at one end, a bust and upraised arm, the hand of which (now gone) seems to have held a cantharos which occupies the center of the lintel. On the other end is what appears to be the crescent moon. The whole relief has been badly disfigured, but it is possible to see that the head was provided with a crown of rays, which probably signifies that it was meant to represent some deity. The cantharos is unmistakable, being in all respects like the familiar drinking cup represented in the hand of Dionysos, upon Greek vases of all periods. If the crescent at the left side of the lintel represents the moon, it may help to identify the head with some special cult.

Further toward the center of the Djebel Rîha, high up among the hills, are two sites which are unusually rich in sculpture. The larger and more important is a ruin called Frikya, now inhabited by a small number of families who have built their miserable houses out of the ruins of the ancient town. On the outskirts of this ruin are two tombs which contain the most remarkable sculptures of the whole district. One of these tombs, situated to the south of the ruin, is of a form quite common in the country. It is partly

Photographed by Bierstadt.

FIG. 1.—SCULPTURED LINTEL, RUWÊHA.

FIG. 3.—SCULPTURES UPON FAÇADE OF TOMB B, FRÎKYA.

rock hewn and partly built of well-squared blocks. The rock cut portion consists of a broad dromos and, at the end of it, a great arcosolium. The dromos is covered by a barrel-vault of dressed stone. The sculptures appear on the rock-hewn walls of the dromos and upon the spandrils of the arcosolium. On the right wall is an elaborate group in high relief, life size, representing a funeral banquet. Two figures form the center of the group (Fig. 2). They are a man and wife reclining upon a couch of the same type as those in the Dêhes tomb, with its dolphin at the head and its turned legs. The wife occupies the front of the couch and the man, who reclines a little nearer its head, has placed his arm over her shoulder, as we see the husband and wife represented in so many Etruscan and Roman groups. Before them is a small table upon which is spread the funeral repast, and on one side a little dog has leaped up to help himself. In front of the couch stood a female figure, executed in the round above and in relief below. The

Photographed by Bierstadt.

FIG. 2.—FUNERAL BANQUET RELIEF, TOMB A, FRIKYA.

upper portion had disappeared but, attached to the side of the couch, we found the drapery from the knees down, and a jug which the figure held in its hand. At the foot of the couch, in relief, is the figure of a female slave, holding up the draperies of the couch. At the head stands another figure in relief, that of a young man with a crook, like a pastoral staff, in his hand. The inter-relations of the various members of the group are not left to be inferred, for their names are plainly written on the flat surface of the relief. The man was Abedrapsas, the wife was Amathbabea; beneath the woman's name is written Amathbabea, "the daughter," and beside the other figure, Eirene, "the slave." The figure of the young man with the crook is designated by the words Τ υχη αγαθη.

Above this large group is represented, in low relief, a long procession of small figures wending their way toward an altar at the extreme right. The relief has been so badly disfigured that it is impossible to make out the separate figures distinctly, but the altar at one end and a seated figure at the other are quite plain. Above this frieze is written one word ΒΑΡΑΧΟΥ. On the opposite wall of the dromos appears a line of ten busts of life size, now completely defaced, but upon close examination, one may discover that the heads are alternately that of a man and that of a woman. Over the heads of the men are written their names, Gennealis, Romanos, Bizos, Pamphilos and Dionysius. They were undoubtedly the sons of the family, represented with their wives. In the spandrils of the arcosolium are two medallions set below the surface; one embraces a single bust—that of a woman —the other, two busts, apparently a woman and a man. On the wall of dry masonry above the arcosolium are two inscriptions, one of which gives the date, which Prof. W. K. Prentice reads 324 A. D. It is a curious fact that these inscriptions were copied, though incorrectly, by Pococke over a hundred years ago. But the old traveler apparently had no eyes for the sculptures, at least no mention of them is made in the Greek corpus (4463-4 and 98-99) where his copies of these inscriptions appear. The reliefs were not hidden in Pococke's time, for we had to excavate only about one-third of the funeral banquet group; but the study of the history of sculpture had not assumed any very great importance at that time, when the Elgin marbles could be had for the taking.

At the opposite end of the town from the tomb of Abedrapsas and Amathbabea is another sculptured tomb of rather different character. This tomb (Fig. 3) is entirely rock hewn; it has no dromos. The surface of the living rock on the hillside was simply cut to a perpendicular surface. Then a broad arch about twelve feet wide and eight feet deep was cut, forming a sort of vestibule before a large arcosolium. The great arch of the vestibule was supported in the middle by a rock-hewn column—hardly a canonical architectural motive—but rock-hewn tombs are not bound by constructional rules. The outer face of the arch was adorned with reliefs; the side walls of the vestibule were provided with niches and statues cut in the living rock. On either side of the arcosolium was a statue in a niche, while small reliefs adorned the crown of the arcosolium, the pedestal of the column in front, and the side of the sarcophagus. Various other small reliefs were executed wherever the surface offered.

Let us begin with the face of the main arch where we find, in the center, above the crown of the arch, a head of Roman type set within a wreath of leaves. To the left of this a winged Victory, executed somewhat crudely, is flying toward the center with the *stephanos* in hand. At the extreme right is a large round face, like the face of the moon; not a Medusa type, nor with the attributes of the Gorgon's head; but a bland, smiling countenance like that which we find on the reverse of certain old obols of Ephesos. Upon entering the vestibule we find its walls lined with statues in their niches, all a part of the living rock. On the left is a broad niche embracing two nearly life-size female figures in long draperies; both are undoubtedly figures of deities; the first is badly damaged and has been stripped of its attributes, but its companion is undoubtedly Athena wearing her tall crested helmet, resting her left hand upon her shield and holding her spear in her right. The next niche is in the rear wall beside the arcosolium. Here we have a male figure, draped to the knees. The face, like all the others, has been destroyed, but over his left shoulder the *caduceus* gives us the clew to the figure's identity. Thus far, then, we are able to recognize Athena and Hermes. On the opposite side of the arcosolium is a figure which is not so easily identified. It is unquestionably that of a male and is draped, like Hermes, to the knees. Above the left shoulder the end of a staff is plainly visible; this terminates in a bulb tied with ribbon. It is not impossible that this is the *thyrsus*, and that the statue was meant for Dionysos.

On the right wall the theme suddenly changes; here, instead of a pair of goddesses to match Athena and her companion on the opposite wall, we find the broad niche occupied by the reverend form of some high dignitary, seated on a throne, with flowing robes falling over his knees and displaying his feet, which are incased in shoes. The venerable head, which is poised slightly forward, wears a tall tiara which, at first glance, we would at once pronounce a miter; but at the peak, instead of the cross, or some other Christian symbol, we find the inverted crescent; and above it appeared something else which has weathered away

but which seems to have had the form of the so-called Greek cross. Upon discovering this figure we instantly named it the Bishop, in spite of the crescent upon the crown. But since my return from Syria I have been informed by students of early ecclesiastical insignia, that the episcopal miter was not introduced until the later middle ages, though it is not known if this was not a revival from more ancient times.

One other point is worthy of notice in connection with the identification of this statue; that is, the presence of the remains of a band which appears on either shoulder, bearing strong resemblance to the upper part of a stole, but the breast and lap of the figure have been intentionally defaced and we cannot discover how these bands terminated or what the other vestments were. But if this be the statue of a bishop, what is he doing here among this assemblage of gods and goddesses? This is a difficult question to answer. It is interesting to notice that this seated figure is executed in a style more crude and conventional than that of the other figures, which are pagan and must have been executed before the middle of the fourth century. Moreover, the niche in which it is placed is much deeper than that opposite, and has every appearance of having been deepened after the original niche was cut. It is not impossible that two figures, like those in the opposite niche, were cut away and that the seated figure was then carved in the solid rock some years after the original tomb, which may have been designed symmetrically, was made. The seated figure is, of course, anterior to the Mohammedan invasion, and the progress of art, in this region, seems to have been arrested early in the seventh century. The very latest date that we found was 609, and the greatest activity in Christian era, here, from the inscriptions, would seem to have been during the fifth and sixth centuries.

These sculptures may prove to be a combination of pagan and Christian motives without conversion which was so common in the declining period of Roman art.

Above the crown of the arcosolium are two small busts, in rather low relief. They stand side by side; one wears a raying crown; in the other, the crescent moon appears above the head, the pair suggesting the deities of day and night. Three rather crudely wrought, or perhaps unfinished, reliefs appear on three sides of the pedestal of the central column of the vestibule. They represent three musicians; one playing a bagpipe, another an organ with long reeds; the third holds a large instrument shaped like a harp; but the surface is quite smooth and we may not be certain what it was meant to be. None of the minor reliefs present the excellence of style or technique which the large ones exhibit and must have been executed by another hand.

There is not sufficient space in a paper of this kind to discuss these sculptures critically; but, speaking briefly of the statues in this tomb, and the funeral banquet of the other, one may say that there is a force and freedom in the style of these sculptures not common in the later Roman sculptures which are familiar to us in the museums of Europe, and a grace in the pose of the figures and the flow of the drapery which shows that the artists were familiar with the best classic monuments existing in their day.

The influence exhibited is purely Greek, not oriental; the banquet group bears far stronger resemblance to the famous Greek funeral monuments of a much earlier date, than to the Palmyræan monuments of a similar nature, that were about contemporary with them. So much of the detail has been ruthlessly destroyed that it is difficult to secure an idea of the technique, but the lower part of the draperies and the feet of the deity figures illustrate great care and perfection of treatment, when we consider that the material is a friable limestone. Had they been executed in marble they would doubtless take high rank among the sculptures of the Empire.

Other sculptures of a funeral character are to be found upon some of the sarcophagi. Those which are raised upon pedestals are not sculptured, but there is another variety in which the receptacle for the body is cut in the natural rock and covered with a huge sarcophagus lid. In some of these, one side of the tomb is cut perpendicularly to represent one side of a sarcophagus; and one of this style was found which was ornamented with relief sculpture. This example is near a village called Shnân, not far from Frikya. The reliefs represent three genii of Roman type, bearing garlands between them. Above the semi-circles described by the garlands were two faces which are now completely obliterated. The genii are interesting in their grace of pose and the ease and variety of movement which they present. But here again the weather and the ruthless attacks of men's hands have forbidden a minute study of the execution. Many of the sarcophagus covers are shaped like a steep, gabled roof, with huge acroteria at the angles and sometimes one in the middle of either side. The ends of the covers, which are like small pediments, are occasionally filled with sculpture. We found two of this type; one at Khirbit Hâss, and one at Dêr Sambil. The former presents a single bust, the latter two. The Dêr Sambil tomb is of the same type as the genii sarcophagus near Shnân; that is, one side of it is cut down perpendicularly and sculptured. This side was almost completely buried, but the head of a figure protruded above the soil. It was something of a surprise, on excavating, to find that this one figure, at the extreme end of the side, was the sole decoration. It proved to be the figure of a boxer wearing the cestus on his hands and standing in one of the positions of the contest.

There remain but two other sculptures of importance to be discussed, both of them cut upon the surface of huge rocks in the open country. The first is near Shnân, at a considerable distance from any architectural ruins. It is situated upon a hillside; a huge bowlder has rolled down and planted itself directly in front of the relief, so that I was unable to take a photograph of it. The relief presents the figure of a man in armor, very nearly life-size, with a lion standing behind him, a diminutive figure at his right side, and a serpent coiling up from a vase on his left. The warrior is of that type which we are wont to associate with St. George or the Angel Gabriel, though of course he can bear no relation with either of these personages. He wears a close-fitting corselet with flaps falling to the knees, his hair falls in long ringlets over his shoulders, he wears no helmet, at his side is a short Roman sword. The body of the lion is partly concealed behind the legs of the man, but his head, with its flowing mane, is turned toward the spectator on the left of the relief. The animal is well drawn and well executed, the mane being represented in conventional curved locks, but the face has rather a human expression. On the same side is a large jar out of which the serpent rises like a stout tree; its head reaches up to the level of a man's shoulder. The group is interesting both in design and execution.

The other free standing relief is at Rhê'ah. It is so badly weathered that it is almost impossible to say what it represented. One can see only a figure mounted on an animal. At first sight, this would seem to be a horse, but closer inspection reveals that its legs are too short, its body too attenuated and its tail too long. It may, then, be a lion. The figure upon its back carries a long spear. Whether it be male or female one cannot say. A figure, in some respects similar to this, is to be seen on a coin of the Emperor Philip, with an inscription which designates it as a Syrian goddess. She is mounted on a lion and holds a long shaft. Near the huge rock, upon which this relief is executed, is the ruin of a very ancient building, with a lintel, in situ, ornamented with two busts and an owl sitting upon the crescent. These are badly weathered. Another relief of a mounted figure, even more defaced than the above, was found at Wâdi Marthûn. This completes the list of important sculptures which were found in the Djebel Rîha.

THE DRAGON-FLY'S FLIGHT AND THE MEANS OF ITS ACCOMPLISHMENT.*

PHYSIOLOGY, whatever its meanings may have been in the past (and they have been quite different at different times), is taken at the present day to mean the study of the workings of the different parts of the body, or of the body as a whole; therefore, it deals especially with the way in which the different changes in the blood or in the parts of the body are produced. Ordinarily we think of physiology as including such matters as digestion, musuclar activity, nervous action, and so on; but of recent years all these various phenomena are looked at from slightly different points of view; in fact, all the changes which take place in the body or in parts thereof may be grouped under changes of form, of matter, and of energy. Without attempting to form any definition of what life is, we can at least be certain in saying that life involves a constant change in form, matter, and energy.

The changes in form are those which one and the same individual undergoes while it is in the egg, in the larval condition (to take a particular group of animals with which we have dealt), and, finally, in the adult condition. The changes in matter are those chiefly which the food and the various substances that make up the body undergo; consequently the changes in matter include all those phenomena which we directly refer to under the head of nutrition; and, finally, the changes of energy are those which energy introduces into the body undergoes until it appears out of the body, or in some part of the body, as another kind of energy. Thus, for example, the chief form of energy which enters the body is the chemical energy which holds together the various atoms of the molecules of the substances constituting the food; and when such food is taken into the body and undergoes various changes in the process of digestion, etc., that chemical energy is transformed either into heat energy, whereby the body possesses a certain temperature, or into mechanical energy, whereby the animal is enabled to make certain movements.

While the changes which constantly occur in an animal's body may be viewed as changes in form, matter, or energy, it is impossible to have any one of these three kinds of changes taking place without a simultaneous change in the other two. Every small, solitary particle of the body changes in form to a greater or less degree at the same time that that part of the body is changed in substance or the energy located in it is changed; so that the changes in matter, form and energy are inseparable from one another, and are occurring all the time, and at the same time.

I propose to devote a considerable portion of the hour to the subject of the flight of dragon-flies, using this as an illustration of some of the changes in energy. Flight is, in itself, a most attractive thing, and the chief endeavors of man, so far as locomotion is concerned, are along the lines of being enabled either by his own efforts or by the efforts of machinery to move through the air; while as to this particular group of insects they are, perhaps, of all insects the most conspicuous in their possesion of very high powers of flight.

In an insect such as a dragon-fly, which moves almost exclusively by flight, the distribution of the organs is largely determined by the requirements of that fact. In any animal which flies it is necessary that the wings shall be situated at such a part of the body that they will be above, and also in front of, the center of gravity; because it is evident that if the wings were attached to the under portion of the body and nearer the hind than the front end, as soon as any even slight draught of air should blow upon such an animal, it would at once capsize. Hence we find that in all animals which fly the wings are attached nearer to the upper than to the under surface, and that they lie in front of the center of gravity. But again, the movement of the wings requires a considerable mass of muscle; therefore it follows that the region of the body which immediately follows the head (i. e., the thorax) is occupied almost exclusively with muscles nearly all of which are attached to or in the immediate neighborhood of the bases of the wings; so that we find in the possession of wings a further cause for the distribution of the various organs. That, therefore, leaves such organs as the chief parts of the digestive, reproductive, and excretory systems to find their place in the hind portion of the body (the abdomen); and the greater length of the body behind the wings as compared with the length in front thereof means also, of course, that the center of gravity is located somewhere behind the wings, and that this greater length behind it is chiefly important as enabling the animal to not only retain its balance, but also to direct its movements through the air; that is to say, to act as a rudder.

The dragon-fly's wings have running from the base to the tip a considerable number of so-called veins. They obtained this name from the belief of the early naturalists that they actually were chambers through which blood flowed; and though some blood does pass through these veins they are, for the most part, occupied by other organs or entirely solid; so that the term veins is not a very proper one. These veins act considerably to secure the other portions of the wing. An examination of the wings themselves will show that the continuations of these veins are to be found along the front edges of the wings, in all cases; while the hind edge of the wing is much thinner and very much less stiff. If we cut across any one of these wings and look at the cut edge, instead of finding the wing to be of a perfectly flat surface, we find that it is zigzag, and that the cross-sections of the veins occupy either the tops of ridges or the bottoms of the little valleys that lie between the ridges. The importance of that zigzag structure in the cross-section is that it causes the entire wing to be folded lengthwise; and the value of having the wing folded lengthwise is, as it moves up and down and strikes the air, it is much stiffer than it would be if the wing were perfectly flat. Taking a piece of paper to represent the wing, it is evident that if it is perfectly flat throughout it offers much less resistance to the air, is much less stiff, than it is when that same piece of paper is folded lengthwise in some such way as we find the wings of dragon-flies to be. To follow out the comparison still more closely, if along each one of these ridges at the tops of the hills or the bottoms of the valleys you imagine a slender rod to be placed, considerably thicker than the paper itself, you will see how it is that the veins strengthen the wings for the purposes of flight. And then again, the great number of these little cross veins, which are also thicker than the membrane of the wing between them, serve, of course, to connect the long veins together, and in that way to cause them to work all together and to increase the stiffness of the wing.

By taking a dragon-fly and placing it under proper conditions, an Austrian investigator obtained a considerable number of instantaneous photographs showing the way in which the tip of a dragon-fly's wings moved. He had an ingenious apparatus by which he could discount, so to speak, the weight of the pieces which held the dragon-fly in position; and he found that if the dragon-fly was held in such a manner that it was able to move its wings but unable to move forward at all, the apex of its wings traced a figure like the figure 8; that if by a change in his apparatus the insect was free (or practically) to descend in the same vertical plane, the apex of any one wing, so to speak, pulled out another figure 8. On the other hand, if the insect by a change in the apparatus was free to fly upward but in a vertical plane, he got a third tracing; and, finally, if the apparatus was so arranged that the insect could move forward, he found that the apex of any one wing traced a fourth figure. He also found that both the hind and the front wing moved together and described similar curves, and that the pairs of the wings on the right and left sides of the body moved in harmony.

In the life-history of the dragon-fly, beginning with the larval condition, the wings are much later in their appearance than the legs. In insects the wings are not modified limbs, as the wings of birds and of bats, are but they are structures that have nothing to do with legs. In other words, the wing of a bird or of a bat is a front leg, composed of the same bones but having different proportional lengths, some of the fingers being more or less developed than others; while in the insect we have nothing of the kind: the wings are entirely different from the legs.

The muscle fibers in the case of the dragon-fly's wings are of the kind called cross-striped, showing alternate bands of dark and light when highly magnified. The dragon-fly uses its wings very rapidly; and we find throughout the animal kingdom that wherever any organ moved by muscles is capable of being moved very rapidly, such muscles are always of this cross-striped kind. We can even go further: the movements of insects proportional to their size are more rapidly executed than the movements of the backboned animals; and in correspondence with that, the cross-striping of the muscles of the wings of insects is a more complex striping than is the cross-striping of the muscles of the backboned animals. Not only that, but the muscles of insects in almost all parts of the body are made up of the cross-striped kind; whereas, in our own bodies the muscles of the limbs are of a cross-striped kind, while the muscles of the alimentary canal and of many of the other internal organs are not cross-striped. So that we have here in the wing-muscles of insects as highly complicated, or even a more highly complicated kind of muscle than in our own bodies; and then when the muscle contracts as it must, in order say to raise the wing, what happens is that each one of these white bands moves nearer its neighbors; in other words, the whole length of the fiber is decreased while its width is increased.

If one takes a dragon-fly larva—particularly a young one sufficiently transparent to be watched underneath the microscope—one can easily see the colorless blood corpuscles moving forward in this dorsal blood-vessel; and when they get to the front end of it, you can plainly see them leave the blood-vessel and pass out into the various spaces between the other organs of the body. In other words, insects have not a complicated blood-vessel system: their blood-vessel system is immensely simpler than ours. When it leaves the blood-vessel and wanders through the different spaces between the various organs of the body, it eventually finds its way back again toward the hind part of the body. It does so because blood is continually being

* Abstract of lecture delivered at the Academy of Natural Sciences of Philadelphia, by Phillip P. Calvert, Ph.D., Instructor in Zoology, University of Pennsylvania, and specially reported for SCIENTIFIC AMERICAN SUPPLEMENT.

pushed forward through the blood-vessel, so that the pressure of the blood following pushes the first blood back toward the hind end, and then it passes in through the openings in the walls of the blood-vessel itself at various points—openings which are guarded by valves permitting the blood to enter the blood-vessel but preventing its escape, the walls of this blood-vessel being of a pulsatile nature, so that they regularly contract and expand. Each time they contract they force the blood forward; each time they expand, blood enters at these openings on the side.

The chief use of a blood-vessel system is to nourish the animal—it carries digested food from the alimentary canal to the various organs. Naturally if an animal is active (and dragon-flies are active), the use of the wing-muscles necessitates a great expenditure of force; it necessarily follows that they must be supplied with food. Why is it that they have not a well-developed system with branches running from this one blood-vessel to different parts of the body, supplying the various organs and wing-muscles with the blood, just as is the case with the backboned animal? The explanation of that is to be found in the consideration of the breathing-tubes.

In addition to the air-tube branches which are supplied to the hind parts of the dragon-fly's intestines to serve as a breathing organ, there are in other parts of the body a great many branches; and these branches—the final ones—practically extend to all the different organs, whether they be muscle, alimentary canal, brain, or nerve; and even up in the head the number of fine branches is very considerable. The same statement holds true for all insects: the air-tubes are very highly branched; their branches are very numerous, and the more delicate branches go to all parts of the body. Here, for example, is a dissection from a caterpillar of one of the white butterflies whose larvæ feed upon cabbage. Here are the air-tubes running along the side of the body; here is the alimentary canal, and here are shown the fine branches which supply the front portion of the alimentary canal. They have nothing to do with breathing at all, but supply the walls of the alimentary canal with air; and that air enters by openings in the sides of the body. The fine branches of these air-tubes pass in and between the various muscle fibers, just as the blood capillaries pass in between the muscle fibers of the backboned animals.

In the human arm, leg and foot, branches of the capillaries convey blood to the individual muscle fibers; so that the blood can actually, and does actually, soak through the very thin walls of these capillaries into the muscles, and in that way supply them with blood.

The use of a blood-vessel system in animals generally is to carry food—not only a solid food or liquid food, but also a gaseous food; so that the air, or rather the oxygen, which is breathed in by the backboned animal into the lungs is then absorbed from the walls of the lungs by the delicate blood-vessels which cover its surface, and then conveyed by those delicate blood-vessels to larger blood-vessels, and then to the various organs of the body. The blood of the backboned animals not only conveys liquid and solid food from the intestines, but it also conveys oxygen from the lungs. How is it that sufficient supplies of food are conveyed to the various organs in such an animal as the dragon-fly? The supply of oxygen which is needful is conveyed by these numerous branches of the air-tubes; they, dividing and redividing through just the same great complexity as the blood-vessels divide in the backboned animals, convey air directly from the outside to the various muscles and the muscle-fibers, instead of having that oxygen conveyed indirectly through the agency of blood as it is in our own instances. We all know that an animal can live for a longer time when solid and liquid foods are absent than when the gaseous food (oxygen) is absent; in other words, a person or any kind of an animal dies sooner from suffocation than it does from starving for want of water or for want of solid food; and that means, of course, that animals can get along very well if the means for conveying solid and liquid foods do not move with such great rapidity as the means for conveying the gaseous food. Hence, if an animal be provided with air-tubes, as insects are, for the rapid conveyance of oxygen to the various organs of the body, they can put up very well with a slower means of transportation for the liquid and the solid foods; and that accounts, then, for the rapidity of movement of which insects are capable, in spite of the fact that they have a very poorly developed blood-vessel system.

As to the means whereby the liquid and solid food is fed to the different parts of the body, very careful microscopic studies made within recent years of the digestion of foods in the insects, and including researches made directly upon the dragon-fly, show that the food taken into the alimentary canal passes to the middle portion lying in the front part of the abdomen; that it is there digested, and then, after having been digested, passes through the wall of the alimentary canal and out into the general body cavity; that is to say, into the space which surrounds the alimentary canal and is between the various internal organs; and that having reached to that space, it simply bathes the various organs that lie in that space. A comparison of these facts with those which result from a study of other animals than insects and backboned animals shows that we can state as a general principle that the degree of complexity of the alimentary canal, of the blood-vessel system, and of the breathing-tubes (air-tubes, respiratory organs) that the degree of complexity of any one of these three is inversely proportioned to the development of the other two; and therefore we have in the backboned animals a very high degree of complexity of the blood-vessel system—the various branches of the blood-vessels extending to all parts of the body, but the respiratory organs limited to one region only (either lungs in the higher ones or to gills in the lower ones); and the alimentary canal in the backboned animals is a comparatively unbranched tube. In the insects we have a very high degree of complexity as regards the branches of the respiratory system of these air-tubes; they extend to all parts of the body. But on the other hand, the blood vessels and the alimentary canal are almost unbranched. Now to make our statement complete, we have to refer to one other group of animals, the so-called flatworms—forms which live both in the sea and fresh water, and which in many external respects resemble leeches, and are often taken for leeches. Here we have absolutely no blood-vessels at all; we have no respiratory organs; no air-tubes nor anything to correspond to air-tubes; but we find that the alimentary canal, instead of being a simple tube, has a great number of branches, and that these branches extend to all parts of the body; so that this completes our statement, and shows that any one of these three organs may be very highly branched, and if so, a comparatively simple condition can exist in the other two of those three.

The energy which enables the dragon-fly's flight to be accomplished is, of course, mechanical energy; and it is displayed in the ability of muscles to contract. In the accomplishment of flight these muscles have one end fastened firmly to the lower portion of the thorax, while the other end is attached to the base of a movable structure, namely, the base of the wing; and when the muscle accomplishes the movement of the wing it does so by shortening its length; and that shortening of the length is the particular way in which the mechanical energy is manifested in the muscles themselves. Of course, what that mechanical energy is we do not pretend to say; but it is quite evident that unless a sufficient amount of food be received and digested, such a movement would be impossible; and we know that every kind of food which is capable of nourishing the dragon-fly is a substance more or less complex in its chemical composition; that a substance of complex chemical composition means that there are certain operations in the substance from all the atoms of the complex substance together; and since we know that that complex food substance is by the processes of digestion decomposed into simpler chemical bodies; and since we know, also, that oxygen must be constantly fed to the muscles; that these digested foods must be fed to the muscles; so we know that the union of oxygen with something or other in the muscles does take place and is therefore comparable to a combustion. We have enough facts at hand, at least, for believing that there has been a transformation of the chemical energy of the food and also of the chemical energy which results when the oxygen unites with the muscles, to furnish the mechanical energy which is displayed in the shortening of the muscles and the consequent moving of the wings; and of course the same statements that have been made with regard to the movements of the muscles of the wings will apply to the movements of muscles which control any other portions of the dragon-fly's body.

A certain amount of waste takes place in consequence of these various changes of matter and of energy; and these waste substances which are formed are due either to actual destruction of muscle fibers or of portions of the alimentary canal, or of portions of the nervous system, or of portions of any other kind of organ; these waste substances being given off chiefly in a liquid form, but sometimes as solids; and such waste substances are thrown into these spaces, or the space which surrounds the alimentary canal and lies between it and the wall of the alimentary canal. Those waste substances are probably poisonous substances, if suffered to remain; but they do not remain. Here on the alimentary canal is a bunch of what looks like fibers. In reality this bunch is a bunch of delicate tubes which, because they were first described by an Italian anatomist of the seventeenth century known as Malpighi, are called Malpighian tubules. It is found that these tubes contain the same sort, or the same class, of waste substances that are found to be given off by the kidneys of the backboned animals; and furthermore, experiment shows that if some purely foreign substance—say like some one of the aniline coloring matters—is injected through the skin of a living dragon-fly, by and by killing that larva, upon examining it after death microscopically it is found that those aniline substances have been absorbed by these Malpighian tubules and are later on passed by these Malpighian tubules into the alimentary canal, and then carried out of the body by the alimentary canal as other undigested substances are.

NESTING SEASON OF BIRDS OF PREY.*

Our general ideas regarding the incubating season of feathered creatures are associated with the early summer. When the trees attain their foliage, affording more secure hiding places for the nests, and warm weather hurries in the delinquent migratory birds from the South, is the time usually allotted to the birds' domestic duties.

But some of our Northern birds do not go very far south in the winter, if they go at all, and they mate so early that the nesting season is pretty well past for them before the snow has disappeared and the trees have begun to bud. One order of birds in particular, the Raptores, including the eagles, hawks and owls, forces the season in this respect. Many of them go no further south than Maryland to nest, and while the snow is heavy on the ground eggs of each of the three species are frequently taken, while before the leaves appear fully on the trees which support the nests the young have grown their feathers.

Just after New Year's the great horned owl begins looking about for a building site. In the lowlands and deep, inaccessible swamps, where the trees grow thick and water covers the ground during the winter and spring, this creature is at home. In the depths of a convenient hollow or upon the old nest of a crow or hawk the owls, after much patching to suit their individual tastes, some time during February deposit their clutch of two or three white globular eggs.

Close sitting is required during incubation at this cold season, and instances have been noted where during a violent snowstorm both nest and mother bird have been covered with several inches of snow. Many owl eggs are destroyed by the crows, who suck them. The owls which choose the hollows for their nesting sites escape this source of danger, and it is strange that more of the species do not utilize these natural tree cavities. But despite its reputation for wisdom above other fowl, perhaps the owl is like a good many human beings with like reputation—its wisdom is mainly a matter of appearance.

The young owls when hatched are white, and resemble balls of thistle down. Small animals, birds and reptiles are included in the bill of fare of the owls, and their nocturnal foraging often brings them into contact with the neighboring poultry yards.

The barred owl is closely allied in habits to the great horned, nesting about the same time and under like conditions. An absence of the long ear tufts and a round, human-like face are characteristics of the species. The deep-toned, mirthless laughter of the barred owls which inhabit the remote swamps of the Eastern Shore of Maryland makes a great impression upon the superstitious colored people living in the vicinity, and frequently causes the woodland to be dubbed "h'anted" in that category of places they refuse to approach after nightfall.

Sometimes in tramping through the woods while the snow is yet deep in the sheltered hollows, you may have seen at the top of a tall tree on which the branches grew sparsely, a mass of sticks, leaves, moss, and roots, which seem to have been dumped promiscuously into a great pile at the intersection of the highest limbs. This is the nest of the falcon or hawk, and owing to their inaccessibility comparatively few persons have inspected such bulky receptacles at close range. Viewed from the top the nest presents a different aspect, and the skill and patient labor manifested in the compact mass of crooked sticks and roots have given it a really artistic curve about the symmetrical cup in which the eggs are laid.

Before the vernal equinox appears, the red-tailed and red-shouldered hawks (the two commonest species of the falcon tribe) have patched up their last year's nests and in many instances have deposited the eggs and begun incubation. In any large area of heavy timber situated somewhat remotely the birds build, and if disturbed and broken up, will build and lay again.

The young remain in the nest until they are larger than their parents, for they become very fat on the rats, squirrels, moles, and other small rodents and reptiles which form the usual diet of both these species of hawk. Occasional raids upon the barnyards have gained for them the name of hen or chicken hawk, and the enmity of the poultry raiser.

The red-tail is much more addicted to the poultry habit than its relative, but through their similarity of appearance the farmers do not discriminate between them, and the red-shouldered, which rarely approaches the poultry yard, is frequently hunted down for the misdeeds of its cousin with the red tail.

The fishhawk is the last of its tribe to mate and nest, and he suffers accordingly. He presents the lesson of a bird of prey being preyed upon himself, for the eagle's habit of robbing him of his well-earned dinner is admitted by all naturalists. Frequently, when hungry, the larger bird follows the fishhawk, and as the latter rises from the water after a plunge, with a cry the eagle swoops down upon the unfortunate fisher and, causing him to drop his prey, will with a sudden motion grasp the fish in its talons and, soaring upward, leave the ill-fated hawk screaming with rage below him. The eagles bully the fishhawks to such an extent that the poor birds are afraid to meet their tormentors, and begin to cry out in a most pitiful manner whenever the eagles appear.

Although much of the eagles' prey comes to them thus with but little exertion, there are times when it becomes necessary for them to work for food. The great birds have been known when pressed by hunger to swoop down upon flocks of ducks, brant, and even wild geese, selecting a particular fowl as the flock scattered, and, giving chase, usually securing the quarry within the flight of a couple of hundred yards. Wounded ducks and other smaller wild fowl are legitimate prey for the eagles, and on fresh-water marshes muskrats which are left in the traps after sunrise are frequently appropriated.

Domestic fowls also suffer from raids of the eagles, and as the farmers are constantly on the watch for a shot at the great birds the species is rapidly diminishing. As scavengers about the shores of the bays and tributaries of Maryland (where the bald eagle is now most generally at home) they are somewhat akin to the vultures, as they appropriate the dead fish and the other flesh washed ashore by the waves. Along the water courses of the Eastern Shore are favorite haunts of the eagles, too, and many nests are in the vicinity of the streams.

Marketing the large timber has destroyed many of the best nesting sites, and few very old nests now remain in the State. At the top of tall old trees in the hearts of the swamps and heavy woodland, situated usually in the vicinity of water, there are still to be found nests of the bald eagle. Their great masses of tangled roots and decayed branches from the surrounding trees or driftwood from the shores are conspicuous landmarks for many miles around. Several cartloads of wood are frequently used in the construction of an eagle's nest and some of the eyries are occupied by the same birds for years.

Two or three eggs of a dull white color and slightly larger than the domestic duck eggs are deposited by the eagles in February and March, and the young birds come out of the shells in time to get the benefit of the great run of fish in the waters of the bay early in the spring. The food of the young birds consists mainly of fish, wild fowl and occasionally small animals.

The birds commonly known as black eagles are the young during their first year, when the plumage lacks the white head and tail which adorn the adult. During the second year the erroneous name of gray eagle is commonly applied to the birds, which do not attain the plumage marks of maturity until the third moulting season.

During April, especially the first of the month, many hawks and owls build their nests, and by the 1st of May, when the song birds begin to mate, the owls and all of the large hawks except the fishhawk have hatched their offspring, or are well under way with the incubating process.

* New York Times.

As all of these species which so prematurely bring forth their young are birds of prey, a reason for the habit lies probably in the spring migration. Eggs of the raptores hatch about the time the woods and fields are receiving their first large consignment of birds from the South, and the young hawks and owls grow rapidly as the migratory wave increases, until, as the last stragglers come in and the song birds begin to seek the shade of the heavy foliage, they are able to leave the nests and forage for themselves.

THE PATERNITY OF WIRELESS TELEGRAPHY.*

There is a belief in France which, rightly or wrongly, is common to all deep thinkers, that the inventor of the electric telegraph without wires, or at least of that small apparatus, the coherer, which is indispensable for the same, is Dr. E. Branly, of the Institut Catholique de Paris. This question seems to be definitely settled, although perhaps not in the above way, when at the same time two distinct facts are brought forward for discussion, the one being the last trials

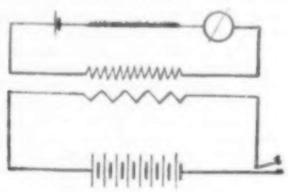


Fig. 1.

of Mr. Marconi to communicate across the Atlantic without wires. These trials are of a nature to render wireless telegraphy a brilliant success. The other question to be considered conjointly is a note on wireless telegraphy published by Mr. Poincaré, a member of the Institute of France ("L'Annuaire du Bureau des Longitudes" for 1902).

Mr. Poincairé writes to the effect that the coherer, or radio-conductor, was discovered independently in France by Dr. Branly, and in England by Dr. Oliver Lodge. Dr. Branly seems to despair, as, when asked by the editor of Figaro, he has replied: "The statement of Mr. Poincairé moves me most because it would have the effect of taking away from me at the same time the paternity, not of wireless telegraphy, but of the discovery which renders that possible." According to Dr. Branly, therefore, the honor of France was in danger. Happily for that country, its honor and glory do not depend on so small a thing. Dr. Branly relies strongly on two things for his claim of priority to the discovery of the properties of metallic filings—first, that it is, thanks to his discovery, that he has obtained the title of Laureate de l'Académie des Sciences; second, that Dr. Lodge has written to him the following letter, dated January 8, 1899: "Permit me to express to you my admiration of your discovery of the variability of the conductivity of metallic powder

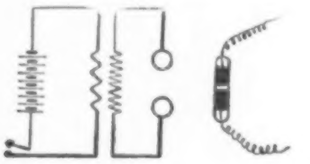


Fig. 2.

under the influence of electric sparks at a distance, and my desire that full justice should be given to your claims of priority in this matter . . . and I would ask you to accept one of my present type of tube of metallic filings as a sample sent in homage to the inventor." The questions to be decided are: (1) if it is Dr. Branly who first discovered the property of metallic filings; (2) if the electric telegraph without wires

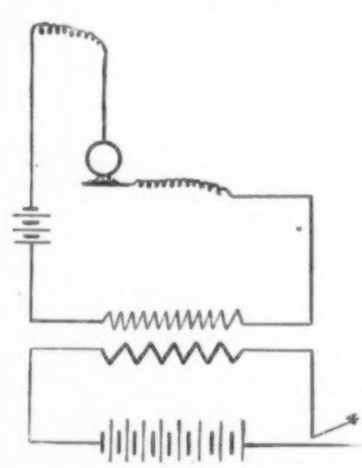


Fig. 3.

is not possible without these metallic powders or filings to indicate the presence of electromagnetic waves by their influence on imperfect contacts; (3) if there are other arrangements which are exceedingly sensitive to act as the receivers of electromagnetic waves without having recourse to imperfect contacts; (4) if one is able to replace the metallic filings or other imperfect contacts by other arrangements for revealing the presence of electromagnetic waves and to employ them to act directly onto a receiver, such, for instance, as the telephone.

In reply to the first question, if one has to choose between Dr. Branly and Dr. Lodge, the evidence of the latter is in favor of the former. As Mr. Poincairé has remarked to the same editor of Figaro who interviewed Dr. Branley, it is simply a question of dates. Thus the work of Dr. Branly dates from 1890 and 1891, while that of Dr. Lodge does not appear in print until 1894, a time when he published his opinion that electric waves could be observed at a distance of half a mile, thanks to the coherer; but there is another person to be noted, Mr. Calzecchi Onesti. Let us take on this subject the statements of a French author, Prof. André Broca, who is professor of physics to the faculty of medicine in the University of Paris. In

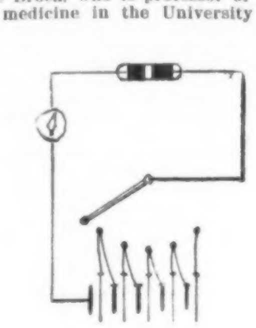


Fig. 4.

his work "La Télégraphie sans Fil," p. 110, he says: "In 1885 Mr. Calzecchi Onesti in Italy had observed a curious fact. It was that iron filings contained in a glass tube placed between two metallic electrodes became suddenly conducting when put between the electrodes communicating with the two secondary terminals of a Ruhmkorff coil. This research passed completely unnoticed." In this we are in agreement with

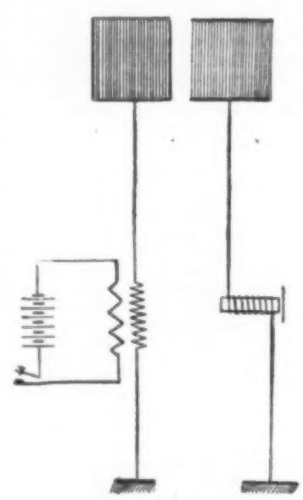


Fig. 5.

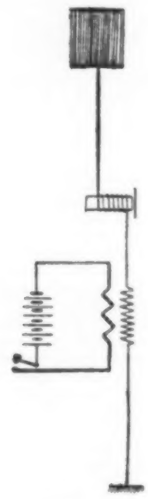


Fig. 6.

Prof. Broca. If the experiments of Mr. Onesti passed unknown, it is no doubt due to the fault of the modesty of this investigator. But we are no longer in agreement with Prof. Broca when he says "this research was not in effect capable of application, and did not present any theoretical importance." This is not so, as it is by these experiments of Mr. Onesti that he discovered the properties of metallic filings. In what in

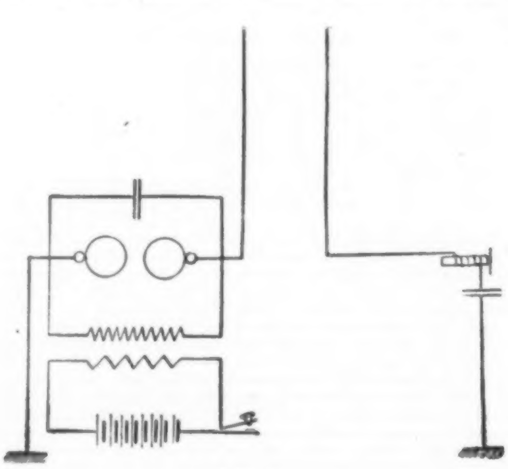


Fig. 7.

effect does this property consist? It is that metallic filings put, for example, between two metallic electrodes present a high electric resistance. But, if for any reason whatever, one causes to pass through the filings a current of a higher tension than a certain value, the resistance of the filings falls to a value which is very much less. The experiments of Mr. Onesti prove well that while the tension in the secondary of a Ruhmkorff coil several millions of volt was higher than the critical tension of the coherer several volts, in effect, when the primary circuit of the coil was closed, the needle of the galvanometer (Fig. 1) inserted in the secondary circuit with the filings was deflected by the current of the battery. Dr. Branly in 1890 proved no more, but much less, than Mr. C. Onesti. Dr. Branly discovered the change of conduc-

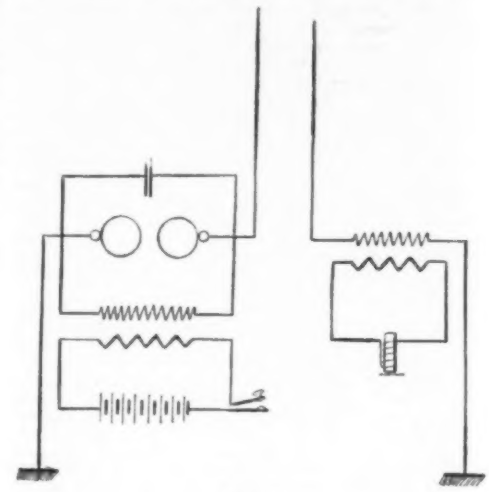


Fig. 8.

tivity of the filings when an electric spark took place near them (Fig. 2). This property had previously been discovered by the Italian experimenter. Again, Dr. Branly had proved much less than Mr. Onesti, because this last gentleman had investigated the general properties of the metallic filings, while Dr. Branly had only investigated one special property, i. e., that of becoming a conductor under the influence of waves

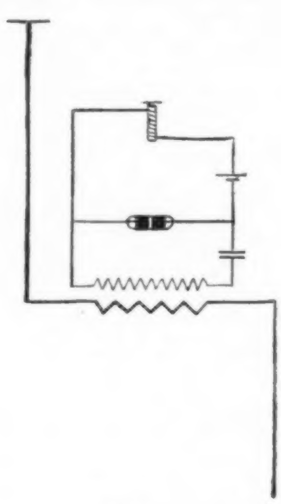


Fig. 9.

produced by the electric spark. It is just where so many make the mistake of believing that an electric spark is indispensable for making a tube of filings a conductor. It is not so, as a variable current of any kind whatever is able to influence at a distance a coherer, or radio-conductor, provided that the current induced in the circuit of the same is of a higher tension to that which is required to render the coherer a conductor, i. e., it is higher than the critical value for the coherer in question. A sufficient tension can be obtained

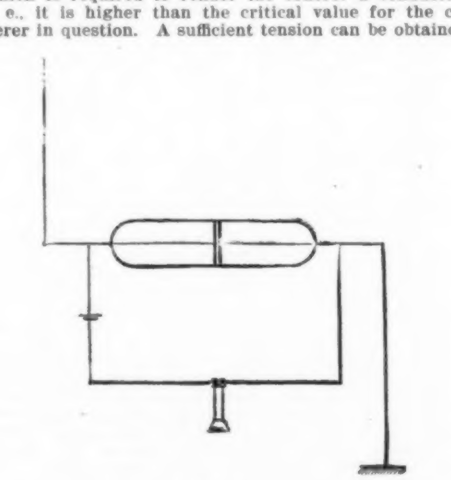


Fig. 10.

by using a transmitter with a high-voltage current, or by making use of a transmitter with a low voltage and transforming up at the receiving end,* or by making use of a transformer at the transmitting end. This last method, actually employed by Mr. Marconi, has the disadvantage over that proposed by Mr. Guarini that dangerous voltages are used. It is through the use of alternating currents influencing at a dis-

* By a Special Contributor to the Electrical Engineer.

* See Guarini's English patent, No. 1555, of January 24, 1900.

tance coherers that Messrs. Guarini and Poncelet have been able to communicate between Brussels, Malines, and Antwerp, with the Guarini repeater (Electrical Engineer, vol. xxviii, pp. 47 and 83). It is also by the arrangements investigated by Mr. C. Onesti that Mr. Thomas Tommasina has been able to use the chains of filings (Fig. 3), 105 millimeters long with brass filings, and 39 millimeters long with iron filings (Archives de la Société des Sciences Physiques at Naturelles, Geneva, vol. vii., January, 1899).

It is not even necessary to have a variable current

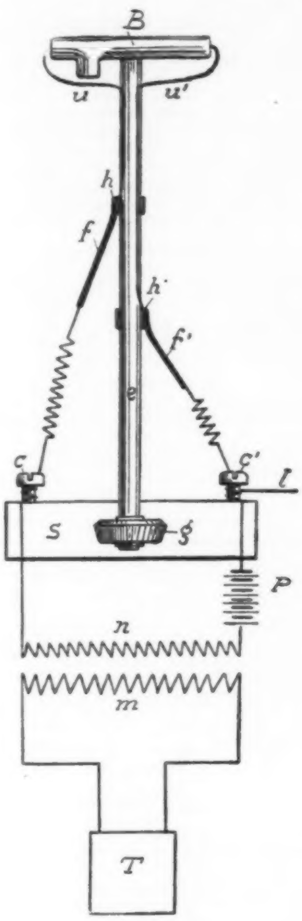


FIG. 11.

B is the coherer arranged to rotate and connected to the transformer, *n*, *m*; *l* is the antennæ; and *T* a telephone.

to make a tube of metallic filings a conductor, as a continuous current will suffice. With these it may be possible to advantageously employ a coherer in telegraphy with wires, notably in submarine telegraphy. The coherer would act as a very sensitive relay. For instance, if one puts a coherer with a critical voltage of five in a circuit with a voltage of 10, the coherer will become a conductor. Here is a very simple arrangement to verify this fact. If one puts in circuit a coherer with a critical voltage of two, and five cells each of one volt in series put successively in the circuit of the coherer, the latter will

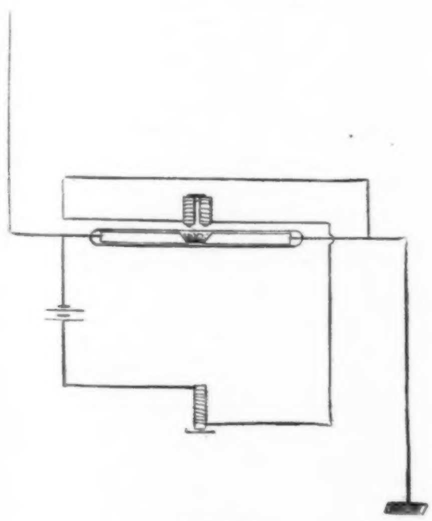


FIG 12.

not become a conductor until after three cells have been inserted (Fig. 4). This being so, it is necessary to admit that the knowledge of the properties of metallic filings is due to the Italian, Calzecchi Onesti, and not to Dr. Branly.

With respect to the second question, metallic filings are not indispensable for the success of telegraphy without wires; any imperfect contact will do—for instance, Messrs. Tommasina, Popoff, and Ducretet employ carbon contacts. By the aid of this very sensitive apparatus, Mr. Tommasina has been able to record storms 250 to 300 miles away, and Messrs. Popoff and Ducretet have sent messages without wires for over 63 miles. It was in 1879 that the late Prof. Hughes discovered that sharp electrical impulses sent into the atmosphere, as, for instance, the extra cur-

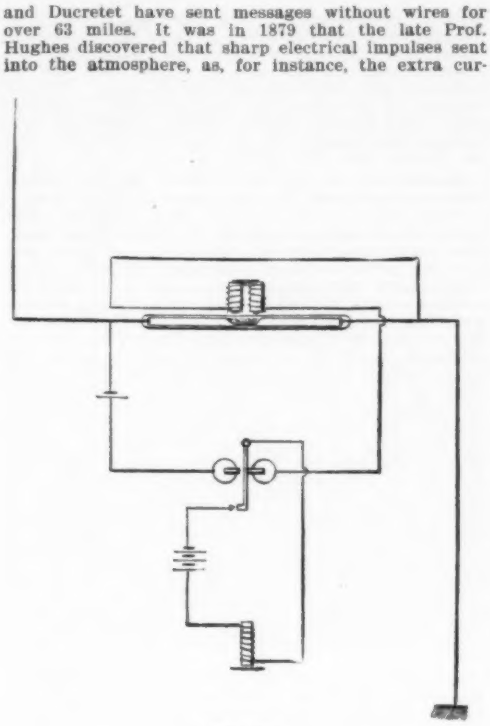


FIG. 13.

rent of an induction coil by a frictional machine, affected a microphone contact.

In reply to the third question, instead of a coherer or other imperfect contact, the electromagnetic waves may be indicated by the electro-capillary electrometer, as has been shown by Messrs. Armstrong and Orling.

In reply to the fourth question, electromagnetic waves are able to induce in circuits, either opened or

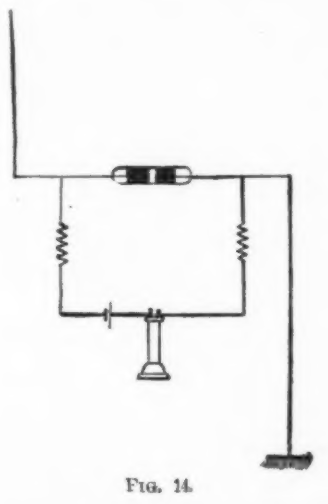


FIG. 14.

closed, currents capable of working sensitive receivers, a galvanometer, or, better still, a telephone. Thus, for example, in 1891, Edison, as shown by his American patent, No. 465,971 of that year, employed the currents from the secondary of an induction coil, connected on one side to a condenser and on the other to the earth, to produce at a distance and without

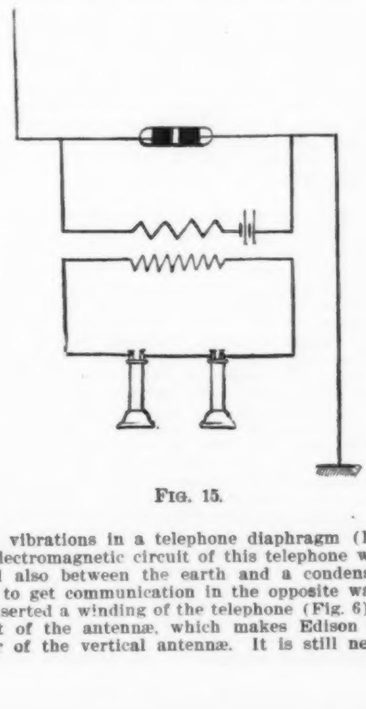


FIG. 15.

wires, vibrations in a telephone diaphragm (Fig. 5). The electromagnetic circuit of this telephone was connected also between the earth and a condenser. In order to get communication in the opposite way, Edison inserted a winding of the telephone (Fig. 6) in the circuit of the antennæ, which makes Edison the inventor of the vertical antennæ. It is still necessary to recall other systems, notably that of Sir. W. H. Preece, for obtaining telephonic communication without wires, and numerous other inventors. The Hertzian waves have also been employed for acting directly on a receiving telephone by Mr. Guarini (Journal Télégraphique de Berne, January 25, 1901). With the arrangement shown in Fig. 7, or, better still, by that of Fig. 8, also with an arrangement absolutely like that of Mr. Guarini, Mr. E. Ruhmer has been able since to exchange signals at a distance of 1¼ miles with antennæ 98 feet long. The future of a wireless telegraphy, especially on land, depends on the power of being able to work directly a sensitive relay, and perhaps a registering the working on a Morse code, as Mr. Guarini describes in his English patent, No. 1555, 1900.

Dr. Branly is not the only French expert who has made researches on the paternity of wireless telegraphy. There is another, Mr. Ducretet, who, with Mr. Popoff, claims to be "the father of a son without wires," which, if not promising great things for the future, promises no less in the present than communication between armed forces on land and sea. Mr. Ducretet claims the priority for the combination of the coherer with a telephone. Thus on January 19, in reply to the editor of a Paris newspaper, he said, "Really the telephone receiver made by me and used by the Russian engineer, Mr. Popoff, in his celebrated experiments in the Gulf of Finland are the most sensitive; these receivers were used by Mr. Marconi in his transatlantic experiments at Newfoundland. The connections of these with a coherer are shown in Fig. 9. It is doubtful if this use of the Ducretet apparatus was authorized. Thus Mr. De Fonvielle, in Cosmos of January 25, says that he is informed that while Messrs. Ducretet and Popoff will not hinder scientific experiments made by Mr. Marconi, they will have to interfere when commercial arrangements are made to work the system. Looking into the justice of the claim of Mr. Ducretet, we find at once that the combination of a telephone and coherer is not really his. Thus, on August 16, 1898, Mr. Blondel sent a sealed communication to the Académie des Sciences de Paris, entitled "Perfectionnements à la Télégraphie sans Fil." In this Mr. Blondel describes the combination of antennæ and earth-plates with an open tube (a special coherer) in circuit with a telephone and battery (Fig. 10). This communication was not opened until May of 1900, and thus does not affect the patent about to be mentioned. On January 5, 1899, Mr. Tommasina stated before the Société des Sciences Physiques et Naturelles de Genève that he had used a telephone in place of a relay. On June 24, 1899, in his Belgian patent, No. 143,444, Mr. Guarini claimed the arrangement shown in Fig. 11. In this illustration a telephone is shown in circuit with a battery and the primary of an induction coil, of which the secondary contains a telephone. Mr. Guarini obtains the decohesion by keeping the coherer always in motion (the theory of this action is described in the English patent, No. 1555 of 1900). On November 21, 1899, Mr. Collins (American patent No. 644,497) patented in the United States the arrangement shown in Figs. 12 and 13. It was only on January 22 of 1900 that Mr. Popoff patented in France (No. 296,354) the arrangement shown in Figs. 14 and 15. A similarity will be noticed between Fig. 15 and that of Mr. Guarini (Fig. 11). This gentleman's Belgian patent was described by him in a pamphlet on the transmission of electrical energy by one wire and without wires, which was published in July, 1899, at Liège. Mr. Guarini tells us that this pamphlet was sent to Mr. Ducretet, who acknowledged the receipt of the same on July 28, 1899. This shows without further comment that it was Mr. Tommasina who first suggested the use of a combination of one coherer and a telephone, and that Mr. Guarini has described the first arrangement with a telephone and another coherer, so that Mr. Ducretet (and Mr. Popoff) have not the right to interfere with Mr. Marconi. It follows clearly from the above that the paternity of electrical telegraphy without wires does belong to Dr. Branly. Thus, Hughes, Edison, Calzecchi Onesti, Branly, Lodge, Popoff, Marconi, Preece, Slaby, Arco, Tommasina, Braun, Guarini, etc., have all in one way or other contributed to the discovery and perfection of wireless telegraphy. If, on the other hand, in speaking of wireless telegraphy, one is confined to that which renders possible great results over long distances, i. e., imperfect contacts rendered conducting by electromagnetic waves—the invention should be credited to the late Prof. Hughes. Science is the patrimony of the whole human race, and it is not well to raise in connection therewith paltry questions of nationality.

A CARBON ELECTROLYTIC INTERRUPTER.

THE loss of platinum in a Wehnelt interrupter by wearing away of the point in dilute sulphuric acid when large currents are used suggested the employment of a cheaper material. Fair results are obtained for a time with an anode of copper wire, well insulated except for one to one and one-half millimeters at the tip, with a lead plate as cathode, but the working is not satisfactory. Other metals and solutions have been tried with indifferent success. The critical voltage below which an interrupter fails to work properly seems to vary with different metals. Although for carbon this point is rather high, it appears to give by far the best results. A new apparatus is described, having as anode a carbon rod 3 millimeters in diameter, immersed in 20 per cent potash solution in a lead jar 27 millimeters in diameter and 80 millimeters high, which forms the cathode and is cooled by water. Heating is also prevented by copper-plating the anode to within 1.5 millimeters of the tip. The rod is inclosed in a tube with a stirrup at the bottom, and as it wears away it slides down the tube and so always exposes the same length. It is adapted for a 6-inch spark coil on a 100 to 110-volt direct or alternating circuit without the use of a resistance in series. By adjusting the stirrup or the size of the rod any other spark length within the security of the coil may be provided for. A minimum direct-current voltage of 65 to 80 is required, and the best results are given between 85 and 110. This instrument is recommended as cheap and simple in construction, well suited for continuous work, and as acting in almost every case

as well as the usual platinum form. As with other interrupters there are certain peculiarities in the spark. Experiments showed that there is no very large electromotive force of polarization in the apparatus, though there is 0.3 to 0.4 ampere "excess current from the carbon to the lead."

A wattmeter indicated a consumption of 62.5 watts for a 6-inch spark, but the latter was "of much greater continuity and energy than that produced by any mechanical interrupter."—London Electrical Times.

CONTEMPORARY ELECTRICAL SCIENCE.

Effect of a Transverse Magnetic Field on Metallic Resistance.—E. van Everdingen recently gave an investigation of the effect of magnetic force on the resistance of metals, and came to the conclusion that the theory that the electric current is carried by charged particles which move freely through the metal requires the resistance to be diminished by a transverse magnetic force and not increased. His results were based on the assumption that the corpuscles which carry the current behave like a perfect gas, that the collisions which the corpuscles make with the molecules through which they move are similar to those which take place between hard elastic bodies, and, thirdly, that the corpuscle between two collisions is free from any force except that due to the external field producing the current. J. J. Thomson had previously come to the opposite conclusion—namely, that the resistance ought to be increased—and he now gives the reason for adhering to his original opinion. The second and third of the above assumptions seem to him extremely unlikely. The corpuscles are highly charged, and are always within a distance of less than 10^{-7} cm. of the molecules of the metal; it is almost certain, therefore, that the local forces exerted on the corpuscle by the surrounding molecules are enormously greater than those exerted by the external electric field, and that at the end of its free path the corpuscle rushes into or past the molecule with which it is colliding with a velocity very large compared with that with which it started. While the value of the second term in the author's equation is uncertain, depending, as it does, upon the law of force between the molecule and the corpuscle, this uncertainty is not important, as the effect of it is small compared with that of the first term, which gives an increased resistance in a magnetic field.—J. J. Thomson, Phil. Mag., March, 1902.

Electrical Resonance of Metal Particles.—R. W. Wood has made some experiments which lead him to believe that he has found a new type of light absorption, which it may be possible to refer to the electrical resonance of small metallic particles for waves of light. The experiments of Garbasso and Aschkinass have shown that a plate of glass covered with uniformly arranged strips of tinfoil of equal size, which serve as resonators, shows the phenomenon of selective transmissions and reflection for electromagnetic waves of different wave-lengths. In other words, a plate of this description exhibits the electrical analogy of surface color. The author has succeeded in producing metallic deposits on glass which the microscope shows to be made up of particles smaller than the wave-length of light, which, by transmitted light, exhibit colors quite as brilliant as those produced by aniline dyes. He is unable to explain these colors by the principles of interference and diffraction and at the present he favors the hypothesis of electrical resonance. The metallic deposits are obtained by heating small fragments of the alkali metals in glass bulbs, thoroughly exhausted and hermetically sealed. Only the small portion of the bulb on which the metal particle lies is heated, leaving the remainder, where the condensation is to take place, quite cold. The metallic film which condenses on the wall, when viewed by transmitted light, shows colors of excessive brilliancy, as brilliant, in fact, as films strongly stained with aniline dyes. Metallic films obtained in other ways, as by chemical or cathodic deposition, do not show these colors. Thin films of metal show a more or less marked color by transmitted light, but the color is fixed for any definite metal, and, except in the case of gold and silver, not very pronounced. The sodium films, on the contrary, may be deep purple, blue, apple-green or red according to conditions. The diameter of the particles, as measured with the micrometer, varies from about 0.0003 mm. to 0.0002 mm. In other words, they are of about the size of the smallest micrococci described by the bacteriologists. Local heating to a slightly higher temperature drives off the film entirely, leaving the glass perfectly clear. By means of a small flame, it is possible to drive a patch of color all over the inside of a bulb, and it is in this way that some of the best films are prepared. It was found that cooling the films by the application of ice to the exterior of the bulb produced most extraordinary changes of color. Pale green films, almost transparent, on being cooled 10 or 15 deg., change to a violet as deep as that shown by dense cobalt glass. Pink films change to a deep blue-green, while films originally deep-blue become transparent. The author believes that we have color phenomena quite unlike any that are already known, and which are of some interest, regardless of the ultimate explanation which may be given them.—R. W. Wood, Phil. Mag., April, 1902.

Vacuum Tube Apparatus.—The growing importance of vacuum phenomena in electrical science makes their study even in elementary classes a desirable thing. Such study is, however, often hindered by the costliness and variety of the apparatus required. W. B. von Czudnochowsky has, therefore, devised a universal apparatus consisting of a number of interchangeable parts, which may be made to answer most purposes of illustration and research. The main body is a vacuum bulb with four tubes attached, the whole forming a cross. One of the tubes contains the anode, and the opposite one is the tube to be connected to the mercury pump. The two remaining tubes have wide mouths, and are intended for the reception of different cathodes and anti-cathodes, including plane and concave plates, hollow cathodes, after Goldstein, and wire cathodes. The anti-cathode is either a flat table on which various substances can be mounted for exposure to cathode rays, or a slanting platinum plate for producing Roentgen rays. Among the phenomena exhibited are the stratified discharge, luminescence and coloring under the influence of cathode rays, and the deflection and reflection of cathode rays. The exhaustion of the tube only requires some 20 minutes with a good mercury pump, as found nowadays in most physical laboratories.—W. B. von Czudnochowsky, Ann. der Physik, May 15, 1902.

Observation of Auroras.—When delicate instruments are employed for the detection of auroras, it is found that they are of much more frequent occurrence than is usually supposed. E. Wiechert has, therefore, constructed a special spectroscope of large aperture and power sufficient to separate the two D lines. Observations were made at the new geophysical observatory near Göttingen, where the elevated position and distance from towns offers a fairly clear sky. On the evenings of November 1 to 9 the auroral line was distinctly seen in the northern sky, and the author was led to believe that it is always present, but observations on clear December nights showed that it could be entirely absent. On January 31 even the more sensitive Rutherford prism failed to detect the slightest indication of an aurora. On February 28 and March 3 the line was seen all over the sky, and most brightly in the eastern portion of it. On the latter date the sky was sometimes overcast, with the exception of small gaps between the clouds, and through these gaps the auroral line was distinctly observed. In all these cases nothing was to be seen by the naked eye except a faint general luminosity of the sky, not half as bright as that of the Milky Way. If the phenomena happen at a height of not less than 30 miles, they should be discernible by the same method as far as the south of Italy.—E. Wiechert, Physikal Zeitschr., May 15, 1902.

Conductivity of Insulating Liquids.—G. di Ciommo has studied the effect of mixing two insulating liquids upon their electric conductivity. In the case of liquids of very high resistance the author connected one of the electrodes of the resistance vessel with a battery of 100 Daniells, and the other with the needle of an electrometer. The resulting conductivity was calculated from the charge dissipated from the needle. Benzol, toluol, hexane and ethane were examined in this manner. More conducting liquids, like carbon bisulphide and chloroform, were studied by finding the loss of charge undergone in a given time by a condenser having the liquid for a dielectric. Two liquids were then mixed in a certain proportion, and the resulting conductivity was calculated on the supposition that the conductivities would be in proportion to the constituents. But this was found not to be the case. When the liquids had separate conductivities of nearly the same amount, the resultant conductivity was found to be higher than anticipated, and the difference was greatest when equal proportions were mixed. When the two original conductivities differed widely the usual process was that the difference between calculated and observed values began at zero, increased with further solution to a maximum, passed through zero, went down to a minimum, and tended again toward zero as the other pure liquid was approached. The results show that ionizations cannot be simply added as they can in extremely dilute solutions of electrolytes, and that the mixture of two dielectric liquids interferes with the normal behavior of the ions of each separate liquid.—G. di Ciommo, Physikal Zeitschr., May 15, 1902.

Optical Properties of Asphalt.—When a thin layer of asphalt varnish is spread upon glass and allowed to dry, and some luminous source, such as the filament of an incandescent lamp, is observed through the film, it is found that a considerable amount of red light is transmitted, the unusual purity of which is readily ascertained by means of a spectroscope. E. L. Nichols remarks that the suddenness with which the rays beyond the red are cut off indicates the existence of a well-defined absorption band with a very steep gradient on the side toward the greater wave-lengths. He obtained films of the requisite thickness by dipping a piece of thin plate glass into asphaltum varnish, and allowing the coating to dry. He found that anomalous dispersion begins to manifest itself between the yellow and green. In the infrared there was a maximum transmission at 2000 $\mu\mu$ and a much steeper gradient up to that maximum than in the case of lampblack. There is much about the optical behavior of asphalt to suggest that its color may be due to the presence of carbon particles dissolved, or perhaps suspended, in some other medium. If a wire ring be dipped into the varnish and withdrawn, it carries with it a flat film of liquid, which is very similar to a soap film in appearance. The coloring matter in this film is not uniformly distributed, as in a solution, but tends to gather into streaks and patches as if by capillary attraction. Upon drying it leaves behind a nearly colorless sheet of resinous material.—E. L. Nichols, Phys. Review, April, 1902.

Ions from Hot Wires.—The curious fact that a hot wire is more rapidly discharged when positive than when negatively charged, has led C. D. Child to a study of the velocity of positive and negative ions as discharged by a platinum wire. He found that the positive discharge commenced a little below the temperature of red heat, increased at first rapidly as the temperature rose, remained nearly constant through a wide range of temperature, and then began to decrease. The negative charge, on the other hand, did not set in until the temperature at which the positive discharge began to decrease, and it never became as large as the positive. The wires were stretched along the axis of a cylinder, and it was found that both the positive and the negative discharge increased rapidly as the difference of potential between the wire and the cylinder was increased. Four different methods were used for comparing the velocities of the positive and negative ions. One of them showed the average velocity of the positive ions to be greater. Another showed the maximum velocity of the positive ions to be greater. A third method showed that, at low temperatures at all events, the slowest positive ion has a much greater velocity than the slowest negative ion, while at higher temperatures the result is doubtful. It was also found that at a certain temperature ionization is produced in the gas about the wire to greater than molecular distances. This is nearly the critical temperature at which the negative ions appear. The experiments also show that particles are present in the tube which load the ions, and thus greatly diminish their velocity.—C. D. Child, Phys. Review, April, 1902.

*Compiled by E. E. Fournier D'Albe in The Electrician.

TRADE NOTES AND RECIPES.

Transparent Soaps.—Below we give some recipes for transparent soaps with various scents without admixture of glycerin.

The mode of production is the same for all the different kinds. The fats are melted together, sifted into a double boiler and the lye is stirred in at 35 degrees Réaumur (111 deg. Fahrenheit). Cover up for an hour, steam being allowed to enter slowly. There is now a clear, grain-like soap in the kettle, into which the sugar solution and the alcohol are crutched, whereupon the kettle is covered up. If cuttings are to be used, they are now added. When same are melted, the kettle will contain a thin, clear soap, which is colored and scented as per directions, and subsequently filled into little iron molds and cooled.

ROSE-GLYCERIN SOAP.

Cochin coco nut oil	70 kilos
Compressed tallow	40 kilos
Castor oil	30 kilos
Caustic soda lye, 38 Bé	79 kilos
Sugar	54 kilos
Dissolved in	
Water	60 kilos
Alcohol	40 kilos
Geranium oil (African)	250 grammes
Lemon oil	200 grammes
Palmarosa oil	1200 grammes
Bergamot oil	80 grammes

BENZOIN-GLYCERIN SOAP.

Cochin coco nut oil	66 kilos
Compressed tallow	31 kilos
Castor oil	35 kilos
Caustic soda lye, 38 Bé	66 kilos
Sugar	35 kilos
Dissolved in	
Water	40 kilos
Alcohol	35 kilos
Brown, No. 120	200 grammes
Powdered benzoin (Siam)	4200 grammes
Styrax liquid	1750 grammes
Tincture of benzoin	1400 grammes
Peru balsam	700 grammes
Lemon oil	200 grammes
Clove oil	70 grammes

SUN FLOWER-GLYCERIN SOAP.

Cochin coco nut oil	70 kilos
Compressed tallow	50 kilos
Castor oil	23 kilos
Caustic soda lye, 39 deg. Bé	71 kilos
Sugar	40 kilos
Dissolved in	
Water	30 kilos
Alcohol	40 kilos
Brown, No. 55	250 grammes
Geranium oil	720 grammes
Bergamot oil	300 grammes
Cedar wood oil	120 grammes
Palmarosa oil	400 grammes
Vanillin	10 grammes
Tonka tincture	400 grammes
Peru balsam	70 grammes
Styrax liquid	70 grammes

LILY OF THE VALLEY-GLYCERIN SOAP.

Cochin coco nut oil	67 kilos
Compressed tallow	31 kilos
Castor oil	35 kilos
Caustic soda lye, 38 deg. Bé	66 kilos
Sugar	40 kilos
Dissolved in	
Water	30 kilos
Alcohol	40 kilos
Linaloe oil	360 grammes
Iris oil	36 grammes
Neroli oil	30 grammes
Sandalwood oil	36 grammes
Aniseed oil	10 grammes
Clove oil	36 grammes
Tincture of musk	250 grammes

LILY-GLYCERIN SOAP.

Cochin coco nut oil	67 kilos
Compressed tallow	40 kilos
Castor oil	30 kilos
Caustic soda lye, 38 deg. Be	70 kilos
Sugar	40 kilos
Dissolved in	
Water	30 kilos
Alcohol	40 kilos
Palmarosa oil	250 grammes
Bergamot oil	250 grammes
Geranium oil	200 grammes
Angelica oil	40 grammes
Lemon oil	40 grammes
Petit grain oil	20 grammes
Clove oil	10 grammes
Cedar wood oil	10 grammes

HYACINTH-GLYCERIN SOAP.

Cochin coco nut oil	67 kilos
Compressed tallow	31 kilos
Castor oil	35 kilos
Caustic soda lye, 38 deg. Bé	66 kilos
Sugar	40 kilos
Dissolved in	
Water	30 kilos
Alcohol	40 kilos
Ceylon cinnamon oil	20 grammes
Bitter almond oil	15 grammes
Tincture of styrax	300 grammes
Hyacinthin	250 grammes

LILAC-GLYCERIN SOAP.

Cochin coco nut oil	67 kilos
Compressed tallow	31 kilos
Castor oil	35 kilos
Caustic soda lye, 39 deg. Bé	66 kilos
Sugar	40 kilos
Dissolved in	
Water	40 kilos
Alcohol	30 kilos
Methyl violet	2 grammes
Terpineol	1200 grammes
Coumarin	20 grammes
Artificial musk	10 grammes
Ylang-ylang oil	20 grammes
Geranium oil	45 grammes
Civet tincture	100 grammes

SPIKE-GLYCERIN SOAP.

Cochin coco nut oil	70 kilos
Compressed tallow	40 kilos
Castor oil	30 kilos
Caustic soda lye, 38 deg. Bé	70 kilos
Sugar	40 kilos
Dissolved in	
Water	40 kilos
Alcohol	45 kilos
Patchouli oil	100 grammes
Lavender oil	400 grammes
Spike oil	200 grammes
Geranium oil (African)	100 grammes
Palmarosa oil	100 grammes

VIOLET-GLYCERIN SOAP.

Cochin coco nut oil	66 kilos
Compressed tallow	31 kilos
Castor oil	35 kilos
Caustic soda lye, 38 deg. Bé	66 kilos
Sugar	35 kilos
Dissolved in	
Water	30 kilos
Alcohol	40 kilos
Brown, No. 120	160 grammes
Bergamot oil	450 grammes
Iris oil	70 grammes
Peru balsam	450 grammes
Tincture of benzoin	3500 grammes
Tincture of musk	200 grammes
Terpineol	210 grammes
Vanillin	10 grammes

—Seifensieder Zeitung, Augsburg.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Tripoli and the United States.—One of the few portions of the known world with which the United States has no commercial relations, to which its products do not filter through by indirect channels, and with which our government does not even maintain communication through the instrumentality of a consular agency is Tripoli, that vast nominal dependency of Turkey bounded by Tunis and the Sahara and Lybian deserts. A few hides and tanned skins reach the United States from Tripoli, but as no representative of the United States stands guard with helpful suggestions, our people have no share in the slowly developing relations of that country with the modern world. Were the situation otherwise, and were our exporters prepared to do business according to the local rule, quoting c. i. f. prices and accepting ninety-day drafts with an optional cash discount, as do others, there is no reason why the word America should not become as familiar in Tripoli as it is elsewhere.

Correspondence for Tripoli is transmitted via Marseilles, which enjoys a weekly steamship service with the capital city. The commerce between the two countries reaches 3,500,000 francs ($675,000), of which 2,000,000 francs ($386,000) represents imports from Tripoli. The exports from this country include cheap silks, cottons, thread, flour, coffee, medicines, sugar, leather and silver plates. The imports consist of skins, ostrich feathers, wool and sponges.

For some months the country has been in a state of excitement, owing to an effort to enforce a conscription law among the Arabs and the levying of a new land and property tax. The enforcement of the conscription regulations should have been commenced on March 14, the beginning of the Turkish fiscal year; but the attitude of the Arabs has been so hostile with respect to this measure that the whole matter has been left in abeyance. The assessors are continuing the appraisement of the land, however, and it remains to be seen whether or not the tax will be imposed later on.

It has been decided to erect a telegraph line between Tripoli and Fezzan, and for this purpose the government has received the necessary wire and insulators. While intended for military purposes, it is also hoped that it will be a means of increasing trade with the interior. Among minor improvements, the custom house, long since inadequate for the storage of goods, is being enlarged.

Trade generally has been in a depressed state, partly because of the feared enforcement of the land and property tax and partly because of deficient rains and consequent poor outlook for growing crops.

The principal article of export from Tripoli is esparto grass, all of which is now shipped to Great Britain. The value of this export amounted in 1901 to $377,500. It may be mentioned incidentally that as the Turkish government keeps no statistics, these and other figures are obtained from private sources. In the same year, sponges to the value of $187,500 were brought into Tripoli by fishing boats, but only one parcel was sold locally, and that to an American buyer, the remainder being taken to the Ionian Islands, the owners holding out for higher prices than were offered. This year the Turkish government has refused to issue permits to other than Ottoman subjects to fish for sponges in Turkish waters, thereby causing great dissatisfaction and loss to the Greek sponge fishermen, who have had this business completely in their own hands.

All the ostrich feathers of Tripoli are shipped to Paris. The exports of 1901 were valued at $140,000.

During the year 1901 Sudan-tanned skins to the value of $152,500 were exported to the United States, and the exports for five months of 1902 have amounted to $91,265. Raw goatskins to the value of $69,500 were shipped to Marseilles during 1901. In former years a considerable direct business in this line was done with the United States, and there is reason to suppose that most of the hides forwarded to Marseilles eventually find their way to the United States.

Petroleum from Russia to the value of $120,000 was imported last year. American petroleum has not obtained a foothold.

Flour to the value of $275,000 was imported in 1901, as compared with $640,000 in the previous year; it all came from France and Italy.

I believe that American firms in many lines could build up a very satisfactory importing and exporting trade with Tripoli if proper efforts were put forth.—Robert P. Skinner, Consul-General at Marseilles.

Free Imports into Yucatan.—The Mexican Congress has passed an act amending the executive decree which will expire on June 30 next,* by which certain articles of necessity imported into part of the Peninsula of Yucatan were exempted from customs and other duties. According to said decree these articles had to be imported through the port of Chetumal on the east coast of the State of Yucatan, and could not be sent beyond the limits of a certain zone. This zone comprised the country formerly occupied by a rebellious tribe of the Maya Indians, who did not recognize the Mexican government. Some time ago the federal government decided to subdue these Indians by an active military campaign, and is now in possession of almost the whole territory. Although this district was a part of the State of Yucatan, the federal government created a national territory under the name of "Quintana Roo."

The act of Congress above mentioned provides that the exempted articles can be imported through any of the seaports of the territory instead of through Chetumal solely. Entry of such articles at the custom houses and forwarding of the same into the interior of the territory will be subject to the same rules as for any other kind of merchandise; and if such articles are found beyond the limits of the territory, they will be seized as contraband and the party responsible punished according to law.

Trade Conditions in South Africa.—Now that peace has been declared in South Africa, there will come an enormous demand for goods. Many farm houses in the Transvaal and the Orange River Colony have had their thatched roofs burned and will have to be reroofed, probably with galvanized iron, a material much used for this purpose here. It will also be necessary for many of the farmers to purchase new agricultural implements, vehicles, furniture, harness, and food for man and beast. Every store will have to be restocked. In short, all enterprises will be started anew, and it will not be possible to get goods into the interior fast enough to meet the demand that will arise.

All nations are awaiting this trade and are preparing for it by establishing direct lines of ocean transportation—all nations except the United States, which, other than an occasional freight steamer, has no direct communication with Cape Colony.

A statement has recently appeared in local newspapers to the effect that a direct line of steamers will be established between Canada and Cape Colony. The Auckland (New Zealand) Weekly News, of March 28 last, also contains an item in which it is stated that the New Zealand government has accepted the tender of the Blue Star Company for a direct steamer service with South Africa. According to recent London advises this line will be put into operation in the near future, with a monthly service between four New Zealand ports and three ports of this colony. The New Zealand government is to grant the new line an annual subsidy of $145,995. The consul-general of the Argentine Republic at Cape Town, it is reported, has completed arrangements for a line of steamers from the River Plata to South Africa, with a view to supplying this colony with Argentine meats and other produce. The first vessel, the "Pampa," was scheduled to leave Buenos Ayres April 30, with 1000 head of cattle and 3000 tons of other cargo. Thereafter monthly trips will be made. The steamers are owned and operated by the Argentine government, and will undoubtedly prove at first an unremunerative venture, but the cattle and grain exporters will enjoy the benefits of a good market.

The United States ships to this part of the world more than twice as much goods as any other country, except Great Britain. We have been sending to South Africa an immense amount of the material required to carry on the war, and this has accounted for much of our increased trade—a trade that will cease when the war ends. It is said that from the beginning of hostilities up to April 3, 1902, the United States has furnished 201,607 horses and mules for service in the British army; also a vast amount of grain, hay, meat, and other articles. Horses will still be purchased to some extent and feed will always be in demand, though in less quantities than at present; indeed, until a different method of farming is adopted here, this country will never be able to raise nearly enough to supply its wants. But when there is no longer a demand for army supplies from the United States, our imports into South Africa will probably decrease to their normal volume, or nearly so; and if we intend to strengthen our hold on the manufactured-goods trade, we must conduct that trade directly, instead of through the hands of our competitors. As British subjects will have a great war debt to pay, they very naturally think that the trade of South Africa belongs to them and will leave nothing undone to retain it. We cannot always depend solely on the superior quality of our goods; greater effort on our part is necessary. Our grain, our flour, our meat must compete with that produced by the Argentine Republic, New Zealand, or Australia. New Zealand timber is certainly as good as ours, and the premier of that colony, Hon. Richard Seddon, in a speech in this city recently, said that his people proposed to handle this trade in the future.—W. R. Bigham, Consul-General at Cape Town.

*See Advance Sheets No. 1125; Consular Reports No. 253 (October, 1901).

Meats and Dairy Products in New Zealand.—I give below a statement of the quantities and value of meats, butter, and cheese exported from New Zealand from March 31, 1901, to March 31, 1902:

Description.	Quantity. Cwts.	Value.	
Meats:			
Frozen	1,871,731	£2,232,385	$10,863,902
Preserved	37,903	125,355	670,040
Butter	219,493	983,224	4,784,860
Cheese	86,476	189,992	924,596

These exports went almost wholly to Great Britain. The increase in the export of butter is very marked, being 20 per cent in quantity and 24 per cent in value.

The dairy industry in New Zealand is advancing rapidly, and the government is doing all it can to promote the trade. Experienced government graders are constantly employed at the principal ports, examining the exports of these products and issuing certificates of quality. It is a rare thing in any part of New Zealand to be served with poor butter. The same is true of beef and mutton.

There are no droughts in New Zealand, and it is a fine grazing country. Cattle are never housed here, as the climate is mild enough for them to be left in the open all the year round.

The difficulty in exporting to the United States is the absence of direct communication by steam. To the west coast, the Oceanic Steamship Company maintains a direct line, with fine modern steamers running every three weeks to San Francisco, but to the east coast there is absolutely no direct communication, which is so necessary for food products that must be carried in a frozen condition with as little handling as possible.

There are steamers running regularly to New Zealand and Australia from New York, and many of them are built to carry meat and dairy products; but they are all English steamers, and on the return voyage go to England, where everything destined for America has to be transshipped, which adds very much to the cost of delivery.

As shown by the figures given, the average cost per pound of the products mentioned is:

Frozen meat (including lamb, mutton and beef), 2½d. (5 cents); butter, 9½d. (19 cents); cheese, 4¾d. (9½ cents). These figures represent the f. o. b. New Zealand cost.

The quantities of the different kinds of frozen meat exported are:

Mutton:	
Whole carcasses, number	1,585,238
Joints, number	63,617
Lamb, carcasses	1,351,145
Beef, cwts. (of 112 pounds)	312,291
Rabbits, frozen in the skin, number	6,501,997
Hares, frozen in the skin, number	12,260

I am induced to send this report as I notice that a trial shipment of New Zealand mutton has recently been made to New York, which was spoken of very highly by the experts who examined it.—L. A. Bachelder, Vice-Consul at Auckland.

Demand for American Horses in France.—American horses are in demand in France. The French army purchases annually a large number of these animals, and on the farms they are gradually displacing cattle for draft purposes. For many years the soil has been cultivated almost entirely with the aid of cows and oxen, but for this work the superiority of the horse is fully acknowledged. The introduction into France of American agricultural machinery—such as mowers, reapers, drills, rakes, etc.—has also led to the use of horses in greater number than ever before. The exodus of laborers from the farms to the cities is still another explanation of the increased demand for draft animals. This exodus is also responsible for the increasing use of farm machinery. The scythe is giving place to the mower, the old-fashioned method of sowing to the modern drill, and these machines are worked best by horses. A leading agriculturalist stated recently that "the demand for agricultural machinery to replace hand labor on the French farms will be greater this year than ever before."

The importation of horses from Argentina and Russia has not been entirely successful—the mortality en route, the high freight rates, and the great change in climate (with regard to horses shipped from South America) make the selling prices in France almost prohibitive.

Colts three to four years old have been successfully imported from the United States. When shipped at this age, the animals are less liable to injury and less susceptible to climatic changes. Care should be taken to send only sound specimens. Upon arrival at French ports, the animals are carefully examined by veterinarians, who exclude all in any way defective. Closer attention should also be paid to the shipping of the horses, many of which arrive in a deplorable condition. Arrangements should be made for properly caring for the animals after they reach their destination. This could readily be done, and the expense incurred would more than be made up by the increased prices that would be obtained.—Walter T. Griffin, Commercial Agent at Limoges.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1397. July 21.—*Demand for American Horses in France—*Tripoli and the United States—Siberian Butter in Eastern Markets—*Decortication of Ramie in France.

No. 1398. July 22.—Land Concessions in Honduras—Bohemia's Soft-coal Production—Petroleum Export from Austria—Proposed German Bank in South Africa.

No. 1399. July 23.—*American Goods in Croatia-Slavonia—Exposition of Sports in St. Petersburg—*American Vines in Bulgaria.

No. 1400. July 24.—Wheat Crop of India—Manchester Exports to the United States—New Mexican Railway.

No. 1401. July 25.—Growing Crops in Germany—Beet Leaves for Fodder—*Trade Opportunities in Finland and Germany—*American Lumber in Aix la Chapelle—Art Exhibition at Turin.

No. 1402. July 26.—Cattle Industry in Paraguay—Lace in Paraguay—New German Shipyard.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

SELECTED FORMULÆ.

Toilet Powder.—

I.

Talcum	8 ounces
Starch	8 ounces
Oil of neroli	10 drops
Oil of ylang-ylang	5 drops

II.

Talcum	12 ounces
Starch	4 ounces
Orris root	2 ounces
Oil of bergamot	12 drops

III.

Talcum	14 ounces
Starch	2 ounces
Lanolin	½ ounce
Oil of rose	10 drops
Oil of neroli	5 drops

—Drug. Circ.

Sealing Wax.—There is an almost endless list of formulæ for sealing waxes, varying greatly in composition, color and cost. We will give you a few formulæ of various kinds. The simplest and cheapest form is as follows:

1. Rosin, common	50 parts
Beeswax, yellow	50 parts

Melt together and add, for red, English red, sufficient; for black, add lampblack; for light blue, add ultramarine; dark blue, Prussian blue, etc.

2. Rosin, American	6 parts
Sodium hydrate	2 parts
Water	10 parts
Plaster of Paris	9 parts

Mix the rosin (powdered), soda and water, and stir until incorporated, then add the plaster gradually, stirring in as added. This should be prepared as needed, as it sets very hard, or the solution of soda and rosin may be kept on hand, and the plaster added as needed. Both these are very cheaply made. A better class of sealing wax for bottle capping is the following:

3. Shellac	23 parts
Rosin, clear	45 parts
Venice turpentine	16 parts
Red lead	16 parts

Melt the rosin in a copper pan, over a slow fire, cautiously stirring in the shellac, and keep up the stirring until the two substances are thoroughly mixed, then in corporate the turpentine. In a separate vessel warm up the red lead, which should be thoroughly dry, and when warm add it under constant stirring to the rosins. The stirring should be brisk, as otherwise the color would sink to the bottom. If a more brilliant red is desired vermilion may be used. A very brilliant and fine capping cement may be made as follows:

4. Colophony, clear	20 parts
Collodion	60 parts
Sulphuric ether	40 parts
Coloring matter sufficient.	

Mix the ingredients, and when the rosin is dissolved, add the coloring matter according to taste. Some of the ainilin colors give brilliant results with this, which is a varnish rather than a cement.

For the finest red sealing wax the following is an excellent formula:

5. Venice turpentine	6 parts
Rosin, clearest American	12 parts
Shellac, best red	20 parts
English cinnabar	8 parts
Baryta	16 parts
Turpentine oil	4 parts

Melt the turpentine and rosin in an earthen vessel, over a light fire, stir in the shellac, and sift in the color and the baryta. Remove from the fire, add and stir in the oil of turpentine, and pour into iron or stone molds. For black, use lampblack; light blue, ultramarine; dark blue, Prussian blue, etc. Cheaper grades of letter wax are made by increasing the rosin and decreasing the shellac, using Canada balsam or pine turpentine in place of Venice turpentine, English red, in place of cinnabar, etc.—National Druggist.

Cologne Water.—

Oil of rosemary	2 parts
Oil of lavender	5 parts
Oil of bergamot	12 parts
Oil of lemon	30 parts
Alcohol	2,000 parts
Water	2,000 parts

Let it stand a month and filter through kaolin.

—Drug. Circ.

Lightning Renovator or Cleansing Fluid.—

Castile soap	4 av. oz.
Water, boiling	32 fl. oz.

Dissolve and add—

Water	1 gal.
Ammonia	8 fl. oz.
Ether	2 fl. oz.
Alcohol	4 fl. oz.

—Midland Druggist.

Glycerin Lotion.—

Glycerin	4 ounces
Essence bouquet	¼ ounce
Water	4 ounces
Cochineal coloring, a sufficient quantity.	

—Drug. Circ.

Ink-Erasing Powder.—The Pratkischer Wegweiser gives the following:

Alum	1 part
Sulphur	1 part
Amber	1 part
Potassium nitrate	1 part

Powder and mix. Keep in well-closed vials. A little of this powder dropped on a fresh ink spot or fresh writing, and rubbed with a bit of cloth or blotting paper removes the mark completely.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of The Supplement, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of The Supplement can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

Combined Rates.—One copy of Scientific American and one copy of Scientific American Supplement, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.